

A Semimonthly Technical Newspaper

Metallurgical & Chemical Engineering

New York, June 1, 1917

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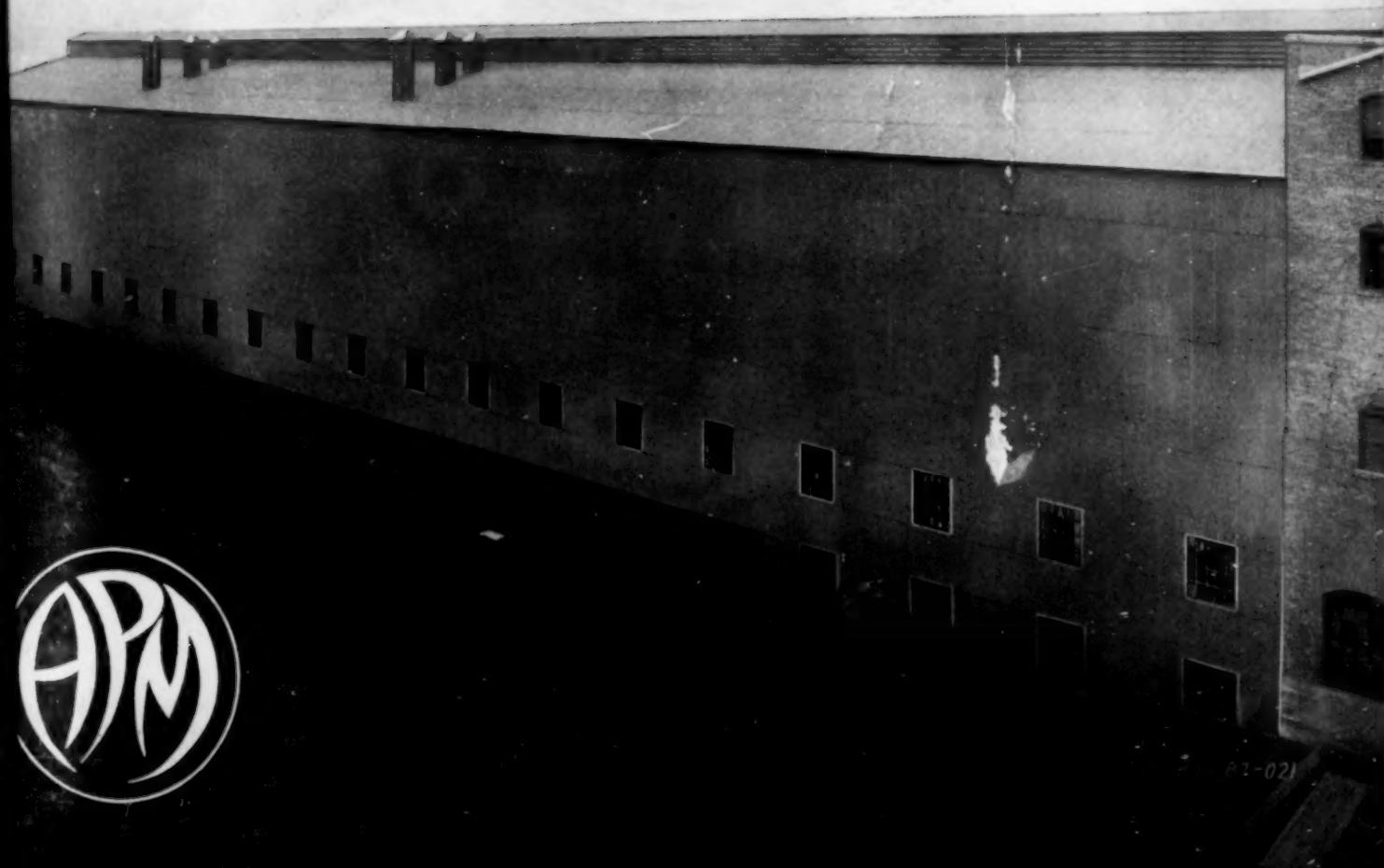
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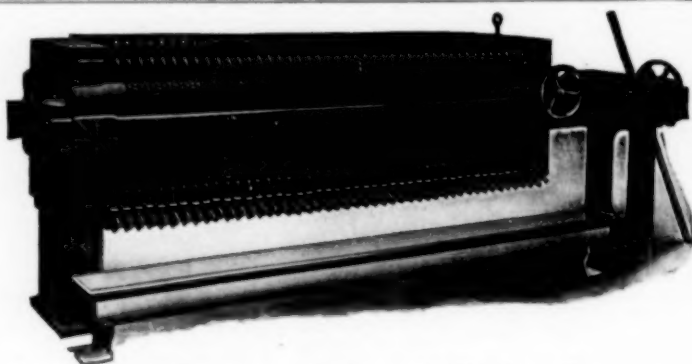
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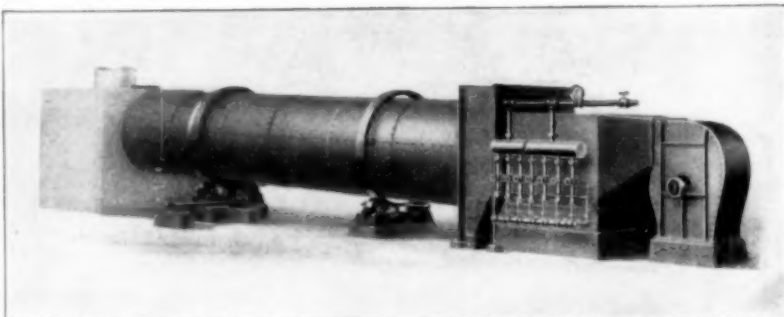
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Government Price Fixing

Since our entrance into the war developments have been so rapid that the opinion that there will be no need for the Government to regulate prices has come to be somewhat less strongly held, and probably it will not be long until a very decided change in opinion will be noticeable.

In many quarters fears have been expressed that the Government would place such large taxes on "excess profits" that business would be injured, that the taxes upon prosperity might be so great as to curtail the prosperity. Now the tax upon some manufacturers or consumers through sharp price advances may be found to be a much more potent influence to throttle their activities than any tax upon excess profits could be.

Suppose, for instance, a manufacturing line in which there are manufacturers with raw materials on contract at $10n$. Other expenses are $2n$ making a cost of $12n$. The selling price is $16n$, and a normal profit of $2n$ is allowed, leaving excess profits of $2n$ on which, say, an excess profits tax of 50 per cent is levied. Then the tax paid is n .

Assume another manufacturer who chances not to be provided with a similar contract for raw materials, and is forced to pay $15n$ for his raw material. In present conditions there are wide divergences in the cost of material to different buyers, by reason of some having contracted more freely than others. This manufacturer's cost is $17n$ and his selling price $16n$ so that his loss is n . One pays a heavy excess profits tax and still has profits of $3n$, while the other loses n . Is the manufacturer who is taxed put out of business?

In the above case the assumption is merely that one buyer pays 50 per cent more for his raw material than another. In the steel industry there is no doubt whatever that in many cases present market prices on certain commodities for early deliveries are much more than 50 per cent in excess of prices at which similar steel is being shipped, against contracts made months ago. An excess profits tax must fall equally upon all competitors, except to the extent that it reduces the amount by which the profits of some exceed the profits of others. The difference in the cost of raw materials falls very unequally and may easily result in some manufacturers being forced to curtail their operations, or cause them an actual loss.

It is a notorious fact that the prices of some commodities in the United States have risen above the level at which prices in England were arrested by Government control, and yet the trend is still upwards.

Any borrower is unfortunate if he is compelled to borrow money when money is cheap and plentiful and repay it when money is scarce. The government converts the

major portion of the money it borrows into commodities, at high prices. If when it repays the loan the commodities are much cheaper the transaction has a very unfortunate element in it. There is reason to believe that soon there will be clearer vision on this subject and that the sentiment in favor of Government price regulation in certain commodities will grow until it becomes really formidable.

Second-Class Postage Rates

There is before Congress a proposition to change the whole second-class postage system for newspapers and periodicals by dividing the country into eight zones and providing increased rates for greater distances. It is a plain war measure. The war requires severe taxation, and the best that can be said for the measure is that if enacted into law it would indeed be effective in raising the average second-class rate; careful analysis for a number of technical journals in various industries shows that the average increase in postage for them would be 250 per cent. But it is certain that the total receipts in dollars and cents by the Government for second-class postage would not be raised to any such extent. First, a number of publishers would undoubtedly be forced to go out of business since after the increase in cost of paper, ink, printing and general operating expenses they would not be able to pay 250 per cent more for postage. Second, the editions would undoubtedly be cut down for the stronger journals able to stand the strain.

The publishers do not object to taxation—severe taxation. They are willing to pay their full share of the cost of the war. But they object to a form of taxation that impairs the usefulness of the technical press at its very root—its fundamental ability to render service. This concerns our readers as much as ourselves. American technical journals are serious journals; in imparting information they connect the East and the West and the South; they connect theory and practice, and they connect different professions, different industries with each other. They are institutions with a true sense of responsibility for the advance of the art. They are the leaders in their respective industries. In this critical time of our country they stand ready to act as an arm of the Government to get the needs of the Government before the industries. They are the educational tools that nationalize the American industries. Nationalized American industry must in the end be the prime factor deciding the war. Can Congress afford to spoil this unifying nationalizing tool by a narrow-minded sectionalizing scheme? Can Congress afford to paralyze the national service of the technical press in a vital hour? It would seem unthinkable.

Steel Production in 1916

The official statistics of steel production in 1916 have just been made public by the Bureau of Statistics of the American Iron and Steel Institute. Our review of the year, in our Jan. 1 issue, commented on the fact the production broke former records by 32 per cent, and there is no occasion to make further reference, as

our estimates then made prove to have been surprisingly close. We estimated the production of steel ingots and castings at 42,500,000 gross tons, the official figure now made public six months later being 42,773,680 tons, or two-thirds of 1 per cent greater, while our estimate of rolled steel was 30,500,000 tons, and the official figure now proves to be 30,557,818 tons, or one-fifth per cent greater. Rolled iron was 1,822,571 tons, against our estimate of 1,500,000 tons. It is always difficult to tell what the iron mills will do. They made 2,200,086 tons of rolled iron in 1907, and dropped to 1,167,776 tons in 1914, while the rolled-steel production was substantially the same in the two years.

Bessemer steel had a sudden revival in 1916, with 11,059,039 tons of ingots and castings. After the production of 12,275,830 tons in 1906, and 11,667,549 tons in 1907, the industry seemed decidedly decadent, but despite the abandonment of a number of converters, and the diversion of some to the practice of the duplex process, the industry came back quite well under the stress for tonnage in 1916. An interesting fact is that some mills have found that with converter and open-hearth furnace capacity designed for duplexing they have been able to secure a greater tonnage output by operating separately. As many consumers were glad to get Bessemer in 1916, there was no hesitation in splitting up the departments. The production of duplex steel in 1916, however, was more than one-half greater than in any previous year, being 3,436,457 tons, against 2,210,718 tons in 1913.

The production of steel castings in 1916 was 1,371,763 tons, against a previous record of 1,020,744 tons, made in 1913.

Comparatively speaking, all iron and steel production records in 1916 sank into insignificance before the gain made in the production of electric steel, which was almost two and one-half times that of any previous year, chiefly by reason of the Steel Corporation's new capacity at the Duquesne and South Works. Electric steel production has been as follows, in gross tons:

	Ingots	Castings	Total		Ingots	Castings	Total
1909...	13,456	306	13,762	1913...	20,973	9,207	30,180
1910...	50,821	1,320	52,141	1914...	15,458	8,551	24,009
1911...	27,227	1,878	29,105	1915...	46,348	23,064	69,412
1912...	14,147	4,162	18,309	1916...	126,048	42,870	168,918

An Interesting Japanese Contemporary

In a late issue we paid our respects to a new contemporary from Japan which bears the title of *The Chemical Technology*, a monthly journal of chemistry and chemical industry. Now, the tardy mails have brought additional numbers, and we take this occasion to repeat and extend our acknowledgments. The covers are printed in three colors; the advertisements and part of the text in two. The subscription price is ¥3.36 per year, which we figure at \$1.68. We do not like to give away secrets, but we doubt if any American publisher could get that monthly issue out at the price with all the color work. The magazine starts at both ends; at what they call the back in Japanese, and at what we call the back in English. The editor, Dr. H. Nishida of

Tokyo, where it is published, deserves great credit, and we felicitate him again on his accomplishment.

Alas, we confess that except for the short English part, which covers only four or five pages, we cannot read it. Let us quote a little and abstract a little, for even the short notes in English are illuminating and abound in information. We have already printed in full in our issue of May 1 (page 505) Dr. Nishida's comments on the dyestuff, synthetic medicine, wood products, glass, celluloid, paper, pulp, phosphorus and potassium chlorate industries in Japan, found in the very first issue of our contemporary. We shall now proceed to quote from Dr. Nishida's notes on other chemical and allied industries from later issues.

Cotton is grown in Japan, but owing to climatic conditions it is doubted if the plantations will ever reach the development of those in China, India and America. In Korea the acreage is increasing. The editor remarks that "its total area of the new plantation during 1916 were 249,236 acres, that makes total area of the cotton farm at Chosen as 303,886 acres. The crop from this total area corresponds to 50,266,400 lb." That would be a little above one hundred thousand bales, as we figure it. In Formosa they have struck oil, and it is claimed that "oil experts join that the petroleum vein at Formosa is quite hopeful."

The cement industry is thriving. Exports last year were 850,000 bbl., and this would have been a round million if shipping facilities had been better. The total production of cement is about 3,500,000 bbl. a year. In regard to textile fibers it is noted that silk and cotton are not the only dry goods of Nippon. Japanese hemp is of very high quality, but unfortunately it is also expensive. Flax is being cultivated in increasing measure, and the Japanese linen industry, as reported in our contemporary, "has acquired new hopeful footstep and the flax plantation belongs to the most hopeful business." Of ramie, for which we thought the climate was too cold, we learn that "up to now its cultivation was not much cared, but recently, having found that South Japan is not unable for the purpose, the government has ordered to Miyazaki prefectural office to research on its practical plantation." We regard this as full of promise. Jute has succeeded in Formosa, but Manila hemp is given up as hopeless for climatic reasons.

Under the heading of Cattles Products it is observed that exports of feathers and leather were 228,000 yen (\$114,000), against imports of eggs, bone, bristle, butter, hides and leather of 8,321,000 yen (\$4,160,000). Of feathers and eggs as the products of cattles it may interest our readers to know that the exports of the former were 64,000, against imports of the latter of 509,000 yen. The figures on machine tools are interesting as showing the effect of the war. They are in yens (1 yen equals 50 cents):

Year	Imports	Exports
1913	27,000,000	8,000,000
1914	17,000,000	9,000,000
1915	7,000,000	23,000,000

We add comparative exports of a number of other articles for the same years, expressed in values in yen (1 yen equals 50 cents):

	1913	1914	1915
Medical instruments	155,000	345,900	870,000
Umbrellas and sticks	677,000	918,000	1,391,000
Boots	455,000	455,000	8,555,000
Toys	782,000	1,208,000	2,077,000
Glass	231,000	341,000	986,000
Electrical machinery	582,000	740,000	1,241,000
Stationery	278,000	479,000	1,300,000

One of the leading industries of the country is that of textile fabrics. According to statistics of 1913 the output of cotton goods was 165,377,234 yen, and of silk 120,326,546 yen, while the exports were 34,840,761 yen worth of cotton goods and 34,222,853 yen of silk. There are five well established and thorough textile colleges in the country.

These notes are taken only from what looks like the front, but really is the back of the journal. The rest is not even Greek to us. We wish it were. Then we should hark back to the memories of our youth and call in the next generation, now at work at that language, and, in happy consciousness of the man of Athens at the peanut stand on the corner of the avenue, feel that the contents might be revealed to us. But it is not Greek, it is Japanese, and to our shame we acknowledge that we are dumb. There are thousands of Japanese who speak English, and even if some of them strain the language a little, occasionally, in getting the ideas over, it doesn't do any harm. That is what language is for—getting ideas over. We, on the other hand, flounder about like fish out of water even before the title of the magazine. It looks like one word, but it may be four. There is a little t and a big T for one unit. The next is opposed E's with a double x between, on a roof over a 3 with a line through it. The next might be a cross section of an I beam, and the last a microphotographic reproduction of a section of a spider's web. But it doesn't mean anything to us; it only bewilders us. Glancing over the pages, we find three horizontal lines, a lean-to roof with two dots, a vertical line, an H gone wrong, a horizontal line, a scythe and a semaphore, and these, we are assured, signify bakelite. Soon after we strike bakelizer, and the only thing they seem to have in common is that roof with the dots. John Wesley Hyatt takes up nearly a column, but is composed of comparatively simple figures, whereas the Badische Anilin & Soda Fabrik looks like a map of Manhattan Island. We do not get ahead with our reading. Turning to the advertisements, there is a picture of a young man and a young woman of the plastered, flat-head, Tenderloin type sitting at a table drinking cocktails. Whether they are tourists or not we have no means of knowing, but we have not heretofore associated these, which are among the very least of God's blessings, as characteristic of Tokyo or any other part of Japan. We thought them almost indigenous to New York and Chicago. But there's no use in going on; we simply cannot make progress with the major part of the magazine. On the other hand, for that little which we can read, we are sincerely grateful.

Readers' Views and Comments

Aluminium Production of Canada

To the Editor of Metallurgical & Chemical Engineering

SIR:—In a table of "Production-Capacity for Aluminium" ("two or three years before the war"), published in your number of March 15 (page 329), Dr. Mailloux gives the capacity, in tons per year, of the aluminium plants in Canada as 2500.

I beg to draw attention to the fact that the Canadian Customs returns for the twelve months ending Dec. 31, 1916, give the "exports of aluminium in bars, blocks, etc.," as 9212 tons, besides a value of over \$26,000 for exports of "manufactured articles of aluminium."

As these figures are exports only, they would imply, I should judge, a much greater capacity of present output for the plant of the Northern Aluminium Company at Shawinigan Falls, as an appreciable quantity of aluminium is used in Canada.

THEO. C. DENIS.

A Fable It Will Seem in Years to Come

To the Editor of Metallurgical & Chemical Engineering

SIR:—The following verses were written by Edwin Markham, the author of "The Man with the Hoe," in honor of Alexander Graham Bell, the inventor of the telephone, and were read on the recent occasion of the presentation of The Civic Forum Medal of Honor for Distinguished Public Service to Mr. Bell:

ALEXANDER GRAHAM BELL

By Edwin Markham

Three wizards called the lightnings to their hands
And witched the world with wonder in all lands.
Morse, with a flower-touch, loosed the winged word
To ride the wires until the world's end heard.
Marconi shakes the ocean of the air,
And sends our words into the Everywhere.
But Bell flings off the cipher and the sign,
And with a cunning nearer the divine,
Lets out across the void man's living voice
To sorrow or rejoice.
Dispels the distances, shrinks up the spaces,
Brings back the voices and the vanished faces,
Holds men together tho the feet may roam,
Makes of each land a little friendly home!

The wires are everywhere,
The tingling nerves of the air.
Be-netting cities, speaking for all hearts,
From floor to floor their whispered lightning darts.
Looping the prairies, leaping hills and lakes,
Over the world their whispered lightning shakes.
They stitch the farms and link the battle-line:
They thread the Alps and down the Congo twine:
They throb among the Pyramids, and speak
Where Fujiyama lifts her perfect peak.

A fable it will seem in years to come:
How Bell gave speech to spaces that were dumb.
A fable it will seem:
He was one man, the one man with the dream.
When youth was on his brow,
He was a conscript burdened with a vow:
He was a man constrained
To seek a vision that the world disdained,
A vision that called laughter to the lips,
Laughters more stinging than the whistling whips.

"Wither the spaces, speak across the miles?"

How could the wise ones cover up their smiles!

"Send out our syllables like flying birds?"

How could the wise ones frame their scorn in words!

But now the deed is done,

And cried before the footsteps of the sun.

Honor the man whose gift from the All-Good

Is shrinking earth into one neighborhood.

And so, great guest, magician of the voice,
We come to crown that gray head, and rejoice.
We gather here to-night

To glory a little in your life's long fight.

Take at our hands this humble wreath of praise

For all the toil and victory of your days.

Take this poor wreath: 'tis all we have to give

To those that nobly serve and nobly live.

What Mr. Markham says of Bell can be said with equal truth of many of our own chemical and metallurgical inventors. A fable it will seem in years to come.

I think Mr. Markham's poem deserves a place in the columns of your journal.

A. B. C.

Coming Meetings and Events

American Institute of Chemical Engineers, semi-annual meeting, Buffalo, June 20-22, 1917.

American Society for Testing Materials, Atlantic City, June 26-30, 1917.

American Chemical Society, Boston, Sept. 10-13, 1917.

Third National Exposition of Chemical Industries, Grand Central Palace, New York, week of Sept. 24, 1917.

American Institute of Metals and Foundrymen's Association, Boston, week of Sept. 24, 1917.

American Electrochemical Society, autumn meeting, Pittsburgh, Oct. 3-6, 1917.

American Institute of Mining Engineers, annual meeting, St. Louis, Oct. 8-13, 1917.

American Society for Testing Materials.—The twentieth annual meeting will be held at the Hotel Traymore, Atlantic City, N. J., June 26 to 29 inclusive. It is probable that means of assistance to the Government will be discussed. The president of the society has already forwarded a letter to President Wilson offering the services of the society and pointing out that the society might be useful in an advisory way in relation to specifications for materials and in a practical way in the inspection and testing of materials. A summary of the program follows:

Tuesday, June 26.—Business Meetings at 11 a. m., and 3 p. m. Presidential Address and Reception at 8 p. m.

Wednesday, June 27.—Business Meetings at 10 a. m. and 8 p. m.

Thursday, June 28.—Business Meetings at 10 a. m. and 8 p. m.

Friday, June 29.—Business Meetings at 10 a. m., 3 p. m. and 8 p. m.

Tuesday Evening.—Reception to members and guests.

Wednesday Afternoon.—Recreation period.

Thursday Afternoon.—Golf tournament.

Flotation Suit Decision of Appellate Court in Miami Case

On May 24, 1917, the Appellate Court in Philadelphia handed down its decision in the Minerals Separation vs. Miami Copper Co. infringement suit.

Judge Wooley wrote the majority opinion in which Judge MacPherson concurred. Judge Buffington, the presiding judge, handed down a dissenting minority opinion.

Judge Wooley, writing the majority opinion, places patentability upon the critical proportion of oil, the greater and different agitation resulting in a commercial froth. He holds that the agitation of the patent in suit is found first in the centrifugal pump, second in the break in circuit, third in the Pachuca tank. He does not find the agitation of the patent in the Callow cell.

He bases his conclusion upon the theory that no experiments were made in court in bubble tank or Callow cell without previous agitation in a Gabbett mixer or agitator, and says that the argument of the defendant is made upon the theory that its process consisted solely in passing thoroughly mixed, but quiescent pulp, directly into the Callow cell where it received its first and final aeration without previous agitation. He says that if the only agitation to which the pulp was subjected, after such agitation as in the prior art was necessary to mix the oil and ore, was the agitation of the Callow cell, he would not say that the agitation amounted to, or was the equivalent of the violent agitation of the patent disclosures and constituted infringement.

He continues that having used the process of the patent in the first three steps (the centrifugal pump—Pachuca, etc.), the defendant cannot escape infringement by taking an additional step, even though that step alone avoids the patent.

The majority of the court thus holds the first, second, and third patents valid and infringed.

Judge Buffington, in his minority opinion, declares no infringement, and agrees with the defendant's position that the agitation disclosed in the patent is a mechanical agitation, and that aeration is a distinctly different method.

* * *

While the majority decision thus appears to be strongly in favor of Minerals Separation, there are various interesting points which must be taken into consideration in connection with the decision.

The centrifugal pump referred to in Judge Wooley's majority opinion was a feature of the original *experimental* Callow plant at the Miami plant, but it seems that it does not form a part of the present *operating* plant of the Miami company. We also understand that although Pachuca tanks were installed in the operating Miami plant, they have not, however, been in operation since shortly after the flotation process was installed as a feature of the Miami operations.

It would seem to be a question, therefore, whether Judge Wooley's majority opinion, basing as he does the act of infringement upon the centrifugal pump and Pachuca tank, which are not features of present mill operations, is not, after all, a contingent opinion, and whether this, in conjunction with Judge Buffington's minority opinion, does not leave the whole question still inconclusive, necessitating still further unfortunate delay in reaching such adjudication as will definitely inform the mining public exactly where they stand in regard to the legal rights of the various flotation processes.

It seems not improbable that appeal will be taken

to the Supreme Court as a matter of right in view of the vast sums involved, and in view of the fact that the Appellate Court was divided, it is not unlikely that the U. S. Supreme Court will take the matter up for final adjudication.

Annual Meeting of American Iron and Steel Institute

The annual meeting of the American Iron and Steel Institute held at the Waldorf-Astoria Hotel in New York, Friday, May 25, was one of the best attended meetings ever held by the Institute. The grand ballroom of the hotel was almost filled when Judge E. H. GARY, president of the Institute, called the meeting to order at 10.15 a. m. Judge Gary made a splendid address in which he outlined the reasons for our entrance into the war and the part we must play owing to our great resources. His address will be found in full on page 634 of this issue.

Following this address, a paper on "Recent Installations of Large Turbo-Generators" was read by RICHARD H. RICE, of the General Electric Co. The paper was discussed by David S. Jacobus, advisory engineer of the Babcock & Wilcox Company, and Alex. Dow, president of the Detroit Edison Co.

The other paper of the morning session was read by ROBERT P. LAMONT, president of the American Steel Foundries Co., Chicago, Ill., on "The Manufacture of Steel Castings." Mr. Lamont traced the development of the steel-casting industry in Europe and America, particularly from the viewpoint of large steel castings. One of the greatest early difficulties in this country was in securing a proper molding sand. By 1887, however, a suitable mixture of sand and molasses had been obtained. Mr. Lamont said, in going over the history of the business during the period 1880 to 1890 one gets the impression that the castings were pushed on the market before the art was fully developed. Very few of the foundries had their own laboratories and the appearance of the castings was against them.

At the present time a very large percentage of all-steel castings produced in the country are used by the railroads.

"Of the approximately two million tons capacity of steel castings in the country to-day about 52 per cent is for basic and 48 per cent acid steel. Almost 90 per cent is produced in open-hearth furnaces, 8 per cent the converter, and the balance crucible and electric. We have no accurate figures showing a division of tonnage as between dry and green sand molds, but the figures are probably not far from 60 per cent green sand and 40 per cent dry sand.

"During the past twenty years the development of the steel-casting industry has been steady and rapid, although, of course, the production has had ups and downs following general business conditions. Beginning with the nominal production of 1684 tons in 1883, by 1897 the production had increased to approximately 100,000 tons. To-day there are about two hundred steel foundries in the country, with a total rated capacity of approximately 2,000,000 tons, though the actual production given for last year was probably about 1,500,000 tons. The exact figures are not yet available. The production curve for steel castings for the past twenty years plotted alongside of one showing, for instance, the ingot production of the country shows a considerably more rapid rate of increase for steel castings.

"While the product cannot even yet be said to be perfect, a great deal of careful, painstaking, intelligent study has been given to overcoming the difficulties in the processes, and it can at least be said that steel castings have to a large extent lived down the somewhat uncertain reputation earned during the first development period.

"A comparatively recent important development in the industry was the coming in of the electric furnace. If it has not already done so, it will entirely replace crucibles and converters as a means of melting. Steel melted in the electric furnace can be brought to almost any state of purity desired, and a very high temperature can be se-

cured. The electric furnace will produce steel of as good quality and at lower cost than the crucible, assuming, of course, a reasonable price for current and sufficient demand to take the output of the furnace."

Mr. Lamont's paper was discussed by R. F. Flintermann, president of the Michigan Steel Castings Company, Detroit, Mich., who said it might be interesting to say something of the development of the small steel-castings industry, where castings are made having an average weight of 20 pounds. These have been made in the converter, crucible, and more recently in the electric furnace. Mr. Flintermann, speaking in favor of the electric furnace, said his company had a 6-ton and a 3-ton electric furnace, and that another will be installed. He said the electric steel castings were superior to crucible castings owing to the more complete deoxidation and the smaller amount of trouble with shrinkage cracks.

In the afternoon session papers were read by JOHN LYMAN COX, of the Midvale Steel Co., Philadelphia, Pa., on "Relative Merits of Forming Steel by Pressing, Hammering or Rolling," by WILLIAM O. SHERMAN, of the Carnegie Steel Co., on "Surgical Discoveries of the War," and by WALTHER MATHESIUS, superintendent of blast furnaces of the Illinois Steel Co., on "The Chemical Reactions of the Blast Furnace." The latter paper is published in full on page 636 of this issue.

In the evening the annual dinner was held at the Waldorf-Astoria. The principal speakers were George W. Perkins, who took as his subject "The Man of the Future," and John A. Topping, who spoke on "Co-operation and the Mobilization of Public Sentiment."

New York Section of Society of Chemical Industry

The last meeting of the season of the New York Section of the Society of Chemical Industry was held at the Chemists' Club on Friday evening, May 25. The chairman, Dr. JEROME ALEXANDER, presided.

A paper on "The Hat Industry of America" was presented by CHARLES D. PARKS, of Danbury, Conn. He said the hatting industry of America, according to the Government census of 1914, was conducted in 223 establishments producing 2,500,000 dozen hats, using approximately 6,000,000 lb. of fur and \$500,000 worth of chemicals and dyestuffs. Less than two per cent of the fur used in the industry is produced in this country. Mr. Parks explained the method of making felt hats and showed samples of hats in various stages of the process of manufacture. Chemicals have been used in increasing amounts in preparing the fur since the introduction of the forming machine in 1846. Quick-silver and nitric acid are used in preparing or corroting the fur. Shellac and alcohol are used in stiffening the felt for derby hats, and a large quantity of dyes is used in dyeing the material. Borax and soda are also used for cleaning stiffened felts.

Dr. A. C. LANGMUIR, of Brooklyn, N. Y., spoke on "The Outdoor Life of the Chemist." He said chemists should pursue some outdoor hobby such as geology, botany, etc., and he gave an intensely instructive and suggestive description illustrated with lantern slides of the many interesting things to be found in the vicinity of New York City.

Congress of Norwegian Engineers.—An informal congress and reunion of American and Canadian engineers and architects of Norwegian birth or descent will be held in Chicago at the Chicago Norske Klub, Sept. 27 to Sept. 29, 1917.

The Petroleum and Gasoline Situation*

By Van. H. Manning

Director of the U. S. Bureau of Mines

I am very glad to have the honor to be permitted to share in the patriotic endeavors of the Business Publishers and to bring before you, and through your public agencies, to the country, one of the, at least to my mind, serious problems confronting the United States at this time. I refer to the production and consumption of petroleum and gasoline in the United States.

Any remedy that can be applied to the petroleum and gasoline situation will come through conservation, which does not mean tying up, but a wiser use of what we have.

In the year 1916 there were 2,750,000 automobiles, or an increase over the year 1910 of 2,350,000.

The increased number of automobiles in 1916 used a billion more gallons of gasoline, or 28,000,000 barrels more, than the automobiles in 1910.

This increased use of gasoline for the increased number of automobiles alone represented a little more than half of the total output of gasoline in the country in 1916 for all purposes, the total production being about 54,000,000 barrels. And when you realize that the number of automobiles is increasing with each day, you can grasp what a tremendous problem is this feature alone.

The total gasoline engine horsepower built and sold in the United States in 1913, according to the Federal Trade Commission, was 11,200,000 and in 1915 the output had a little more than doubled, the figures being 22,500,000.

These figures indicate the increased use of gasoline power more clearly than those which cover only the automobiles, as these include all types of gasoline-driven machines which have been developed and increased in use in a way no less surprising than that of the automobile itself.

The apparently unsolvable puzzle about this is that while we have been increasing our production of gasoline, the production of automobiles has increased 200 per cent above the increase in gasoline production. These are the facts that we must face. Where is it going to end?

Statistics indicate that of the gasoline produced in the United States, between 55 per cent and 60 per cent is used in the automobiles of the country, 20 per cent to 25 per cent is exported, and the balance is used in stationary engines, in motor boats, tractors and for various purposes of minor importance.

As the highways of the country are improved, the commercial trucks, consuming large quantities of motor fuel, are becoming important means of transportation in many localities. The fishing fleets of our entire coasts have installed gasoline power to replace their original sailing equipment. These fleets, with the many pleasure craft, operated mostly in the summer months, when the production of gasoline is most heavily taxed, use large quantities of this convenient liquid fuel. There seems no reason to believe that the call for gasoline will in any way be reduced; in fact, a much larger demand seems imminent.

As the production of gasoline depends upon our supply of petroleum, let us look to the source and see what we find. Petroleum and its products have become essential to our very existence. Gasoline is a very important product, but there are many others. The operation of hydroelectric generators, of railway and trolley cars, of the machinery of the factories, of internal combustion engines, of our battleships and our merchant

*Address delivered before the Editorial Conference of the Business Publishers Association, Washington, May 25, 1917.

ships, in fact, of all machinery, is made possible by the use of lubricating oils, and these come from petroleum. Petroleum lubricates the machinery of the nation from the handicraft of the watchmaker to the dreadnought of the navy.

The industry has progressed since its beginning a little over half a century ago, when it was possible to store the entire production in tin cans and wooden barrels, to the present, when the annual quantity produced requires great steel, concrete and earthen reservoirs for its storage, great pipe lines for its transportation and fleets of specially constructed vessels for its exportation.

In discussing briefly the supply and demand for petroleum in this country for the last few years, permit me to say that the stored reserve of petroleum is the most stabilizing influence in the industry. I wish also to bring out the fact that during the last few months our increased consumption has made it necessary to draw oil from this storage, which has convinced many people that our present supply has reached a point where it may never again be sufficient to fill easily the demand placed upon it, unless some radical steps are taken to conserve its use. One of these steps frequently mentioned, and one that is slowly dawning upon our consciousness, is that the burning of crude petroleum under boilers for the generation of steam ought to be stopped. In this way large quantities of priceless by-products are being consumed.

In the year 1916, the marketed production of crude petroleum was, according to the estimate of the United States Geological Survey, 295,000,000 barrels. The stocks held by various pipe-line and transportation companies at the end of January, 1916, according to various trade journals, amounted to approximately 175,000,000 barrels; at the end of 1916 the stocks amounted to 150,000,000 barrels, which represents a decline of 20,000,000 barrels, even in the face of our greatest annual marketed production of 295,000,000 barrels.

If consumption of crude petroleum exceeds production, the difference must be drawn from storage. The question that naturally presents itself here is what of the future? During 1915 the normal consumption of crude petroleum was 12 per cent greater than in 1914, and last year our consumption exceeded the 1915 consumption by 13 per cent. Estimating that the normal peace consumption for this year will increase at the same rate, or 13 per cent, our consumption for 1917 will exceed that for 1916 by about 40,000,000 barrels. This does not take into consideration the increased demand for petroleum and its products due to the entrance of this country into the war. Although this increased demand because of the war is difficult to estimate, obviously the increased use for various war purposes will greatly enlarge our consumption above the rate which prevailed during times of peace. The production of crude petroleum in this country during last year is thought to have reached high-water mark, and it is very likely that the production for 1917 will be smaller than it was last year. If the normal and war demands for petroleum can be filled, the difference between the estimated production and consumption during this year will amount to probably as much as 60,000,000 barrels, an amount which must be drawn out of storage. With only about 150,000,000 barrels of crude petroleum in storage at the first of this year, and with the prospects of it becoming necessary to draw from that reserve probably 60,000,000 barrels to fill that demand, it becomes more apparent that some radical steps must be taken to meet the situation.

We should not pass over the situation with an optimistic statement that when the time comes new fields

will be discovered, as has happened in the past, or that new methods will be found whereby this threatened shortage will be overcome. We should undertake to anticipate this problem as best we can, for we certainly will encounter it in the not distant future.

While the present increase in the number of pleasure cars may not continue, it is plain that the use of gasoline for power in many commercial fields has not yet fully developed, and as this use widens it will more than overcome any falling off in the rate of consumption of gasoline in the cars used for personal purposes, if such falling off should occur.

The fact we must face is that the production of petroleum is not increasing as rapidly as the production and consumption of gasoline. The petroleum in time will reach its maximum production and start to decline. What we are doing now is looking to more efficient methods of production from the oil sands, the production of more gasoline by the so-called cracking process, the extraction of vapors from natural gas, and the utilization of liquid fuels from other than petroleum bases.

More efficient methods of production are now being developed, such as the Smith-Dunn process for forcing oil from the sand with air or gas under pressure.

The cracking of petroleum last year furnished $7\frac{1}{2}$ per cent of the total gasoline production and can be and is being developed and installed rapidly in most of the larger fields of the United States. Its possibilities are enormous.

The treatment of natural gas by compression, refrigeration and absorption produced 60,000,000 gallons of gasoline of such low boiling point that it was mixed with equal parts of naphtha to form 120,000,000 gallons of good motor fuel. The compression and refrigeration process of extracting gasoline from natural gas, when first used, treated only gases containing three gallons or more of condensable vapors per 1000 cu. ft., but at the present time the development of the process and the increased price of the product make gas carrying one gallon profitable. The extraction of gasoline from gases containing less than one gallon and as small a quantity as one pint per 1000 cu. ft. is now being profitably carried on by the absorption process, which is well adapted to treating lean gases in large volumes. Another source of petroleum which will undoubtedly be developed in time is the shales containing considerable quantities of oil but which, at present prices of crude oil, cannot be extracted commercially.

Substitutes for gasoline, such as the products of the distillation of coal, are being used at present in Europe for motor fuels, and may in time be used for that purpose in this country, as many by-product coke ovens are now being constructed.

Bureau of Standards Analyzed Samples

The Bureau of Standards, Washington, D. C., now has ready for distribution its high-phosphorus standard analyzed Iron E No. 7, which is typical of the irons from the Alabama area. The analysis is carbon 2.17, graphite 1.82, combined carbon 0.38, silicon 2.21, titanium 0.095, phosphorus 0.862, sulphur 0.051, manganese 0.444, copper 0.021, chromium 0.014, nickel 0.016, and vanadium 0.073. The renewal, No. 12b. of the basic open-hearth steel approximately 0.4, carbon, is also ready. Until printed certificates can be secured the above samples will be issued with provisional certificates without details of analysis or description of methods. A new sample of Bessemer steel with approximately 0.1 per cent carbon to replace No. 8a is now in process of analysis.

The Western Metallurgical Field

Ore Dressing

Some Uses of Magnetic Separators.—The use of a series of magnets of different strengths makes it possible to separate materials having different magnetic permeabilities and also to separate magnetic from the non-magnetic ores or concentrates. In treating monazite sands magnetite is removed by the weakest magnet, ilmenite by the intermediate and the monazite by the strongest. The non-magnetic material passes away, giving three concentrated products. Magnetic separators of the multiple-pole type have found application in the dressing of zinc ores. Marmatite, a ferruginous sphalerite, is slightly magnetic, and is separated from the raw pyrite by the most powerful magnet. Non-magnetic zinc-iron sulphide ores require a slight roast to make the pyrite magnetic and the separation of these two constituents is accomplished by the low strength magnets. Franklinite, fowlerite and garnets are separated from willemite, zincite, quartz, mica and calcite by means of such machines.

The literature regarding the magnetic separation of tungsten ores from other ores is somewhat scant. Some tests along these lines have been made, but opinions seem to be at variance with one another. In the Nederland District in Colorado magnetic separation is not in use as yet. On the other hand, magnetic separation seems to be in use in several of the other tungsten camps in the United States. It is absolutely essential that the concentrates obtained from tungsten mills be high grade and uniform in composition. The magnetic tungsten minerals, wolframite, huebnerite and ferberite lend themselves particularly well to treatment by the magnetic separator according to some authorities. In the wet concentration of tungsten ores, the heavy sulphides of iron, lead, zinc, etc., as well as the heavy oxides of tin, magnetic iron, arsenical sulphides, carbonate of lead, garnets and other impurities pass off the tables and contaminate the tungsten concentrates. The multipolar magnetic separator completely eliminates these detrimental minerals. Again there is no market for a mixed product of tungsten and tin, or for wolframite and scheelite mixed, as each of these latter minerals requires a different method for the extraction of the tungstic acid. By passing the combined wolframite-scheelite concentrates over the magnetic separator, the wolframite is removed by the magnets, while the non-magnetic scheelite passes off at the end of the machine.

Magnetic separation is also possible for the following: the separation of pyrrhotite from other sulphides, garnet or gangue; of roasted chalcocopyrite from garnet and epidote; of roasted chalcocopyrite from iron or nickel sulphides; of magnetite from weakly magnetic minerals; roasted limonite from smithsonite and calamine; pyrolusite from quartz gangue; leucite from lava; magnetite from corundum; magnetite, menaccanite, chromite and pyrrhotite from diamond-bearing concentrates; magnetic galena (probably iron-bearing) from zinc ore and gangue and finally hematite from gangue minerals.

Company Reports

Tenth Annual Report of the Nevada Consolidated Copper Co.—The total tonnage of ore milled during 1916 was 3,922,634 tons, averaging 1.632 per cent copper, with an actual mill extraction of 73.87 per cent, the ratio of concentration being 7.45 and the average copper in the concentrates 8.98 per cent. The total milling costs for the year were 55.9 cents per ton as against 53.3 cents for the year 1915. In addition to the tonnage treated as mentioned, the Consolidated

Coppermines shipped 50,911 tons of 1.593 per cent ore to the mill. This was concentrated and the resultant product smelted under toll contract.

During the year many improvements at the concentrator have been made, both for the purpose of increased tonnage and improved recoveries. The Huntington and the Chilian mills were replaced by the tube mills. A considerable number of double-deck tables and other apparatus were installed for the purpose of increasing the concentrating capacity. As the old coarse crushing department of the concentrator is inadequate for the present plan of milling 14,000 tons of ore per day, a new coarse crushing plant was started in July, 1916. It is anticipated that this new unit will be in operation on June 1, 1917.

The eighteen furnaces, initially used in the roaster department, were remodeled to aid in increasing the capacity. Four new furnaces were added to the plant during the course of the year, and the necessary changes in the flue connections were completed. In the smelter department, plans are being considered whereby oil fuel is to be replaced by powdered coal in the reverberatory furnaces. This change is made necessary due to the increased cost of fuel oil and the inability to obtain satisfactory supplies after the expiration of the present contracts.

Increasing the daily capacity necessitated several changes at the power plant. A 20,000 cu. ft. per minute steam-driven turbo-blower was installed to supplement the blowing engine in supplying air for converters and other purposes. A 2000-cu. ft., two-stage, steam-driven air compressor was installed as an auxiliary to the high-pressure air system required for shop work, and a 3000-kw. turbo generator was ordered to cover the power demands of the concentrator, in line with the increased mill tonnage contemplated.

The production of refined copper resultant from the year's operations was 90,735,287 lb. as compared with 62,726,651 lb. for the year 1915. The net operating cost per pound of copper produced was 9.44 cents. Miscellaneous earnings for the year amounted to 1.31 cents per pound, which, if deducted from the actual operating cost, will leave a final net cost of 8.13 cents per pound.

Military Census of New York City's Factories and Mercantile Establishments

New York State proposes to take a census and inventory of the military resources of the State under laws passed this year and the State Military Law. A director of the census has been appointed for each county and one for the city of New York. Mr. E. P. Goodrich, member of the American Society of Civil Engineers, has been given the latter post. A preliminary enumeration has shown that in Greater New York there are about 3200 factories and mercantile establishments in which are employed 400,000 persons, or more than 10 per cent of the estimated total military population of the State. It was believed that this large group of persons could be readily segregated and returns secured from them in their places of employment.

Director Goodrich has asked Mr. Alfred D. Flinn, member of the American Society of Civil Engineers, to organize a volunteer force from among the engineers of the various branches of the profession in New York City, to take this part of the census. It is estimated that 400 or more engineer canvassers will be needed, each giving two full days or more of his time. Letters giving further information and forwarding pledge cards will be sent to the engineers of New York City in the very near future. If any of our readers are able to

help and do not receive such an invitation, they may communicate with Director Goodrich or Mr. Flinn at 261 Broadway, Room 904.

Personnel of Council of National Defense and Its Advisory Commission

Committees and Sub-Committees

The Council of National Defense, at the head of which are the Secretaries of War, Navy, Interior, Agriculture, Commerce and Labor, has an Advisory Commission composed of the following seven members:

Daniel Willard, president Baltimore & Ohio Railroad.

Howard E. Coffin, member American Society of Mechanical Engineers, vice-president Hudson Motor Car Company.

Dr. Hollis Godfrey, member American Society of Mechanical Engineers, president of the Drexel Institute.

Julius Rosenwald, president Sears, Roebuck & Company.

Samuel Gompers, president American Federation of Labor.

Bernard M. Baruch, financier.

Dr. Franklin H. Martin, surgeon.

The members of the Advisory Commission serve in a consulting capacity without compensation.

The Council and Advisory Commission were authorized by Congress, Aug. 29, 1916, and have been very active in mobilizing the industries of the country for war. The headquarters are in the Munsey Building, Washington, D. C. Walter S. Gifford is director and Grosvenor B. Clarkson secretary of the Council and Advisory Commission. Many committees and sub-committees have been formed composed of representative men in the various industrial fields. The chief committees are as follows:

Transportation, including railroad and motor transportation, and Communication, Daniel Willard, chairman.

Munitions, manufacturing, including standardization and industrial relations, Howard E. Coffin, chairman.

Raw Materials, minerals and metals, Bernard M. Baruch, chairman.

Labor, including conservation of health and welfare of workers, Samuel Gompers, chairman.

Supplies, clothing, etc., Julius Rosenwald, chairman.

Science and Research, including engineering and education, Hollis Godfrey, chairman; Henry E. Crampton, vice-chairman.

Medicine, including general sanitation, Franklin H. Martin, chairman.

Under **Raw Materials**, sub-committees have been formed with chairmen as follows: General chemicals, William H. Nichols; fertilizer, Horace Bowker; alkalis, J. D. Pennock; acids, E. H. Grasselli; miscellaneous chemicals, Edward Mallinckrodt, Jr.; cement, John E. Morrow; alcohol, Horatio S. Reubens; aluminium, Arthur V. Davis; asbestos, Thomas F. Manville; brass, Charles F. Brooker; coal tar products, Wm. H. Childs; lumber, R. H. Downman; lead, Clinton H. Crane; mica, L. W. Kingsley; nickel, Ambrose Monell; oil, A. C. Bedford; rubber, H. S. Hotchkiss; steel, Elbert H. Gary; sulphur, Henry Whiton; wool, Jacob F. Brown; zinc, Edgar Palmer; copper, John D. Ryan.

The complete membership list of several of the sub-committees is as follows:

Copper.—John D. Ryan, president Anaconda Copper Company; Murry Guggenheim of M. Guggenheim Sons, New York; R. L. Agassiz, president of the Calumet-Hcla Mining Company, Boston; C. M. McNeils, president of the Utah Copper Company, New York; James

McLean, vice-president of the Phelps-Dodge Corporation of New York, and W. A. Clark, president of the United Verde Copper Company of New York.

Zinc.—Edgar Palmer, New Jersey Zinc Company, New York; Charles W. Baker, president American Zinc, Lead & Smelting Company, New York; A. P. Cobb, vice-president New Jersey Zinc Company, New York; Sidney J. Jennings, vice-president United States Smelting, Refining & Mining Company, New York; Cornelius F. Kelly, vice-president Anaconda Copper Company, New York; N. Bruce MacKelvie, president Butte & Superior Copper Company, New York; Thomas F. Noon, president Illinois Zinc Company, Peru, Ill.; Chas. E. Orr, president Bertha A. Mining Company, Webb City, Mo.

Lead.—Clinton H. Crane, president St. Joseph Lead Company, New York; Fred W. Bradley, president Bunker Hill & Sullivan Mining & Concentrating Company, San Francisco; Edward Brush, vice-president American Smelting & Refining Company, New York; E. J. Cornish, vice-president National Lead Company, New York; Harry L. Day, Hercules Mining Company, Burke, Idaho; F. Y. Robertson, vice-president and general manager U. S. Metals Refining Company, New York.

Aluminium.—Arthur V. Davis, president Aluminum Company of America, Pittsburgh; E. E. Allyne, president Aluminum Castings Company, Cleveland; Jos. A. Janney, Jr., Morris Building, Philadelphia.

General Chemical Committee.—William H. Nichols, chairman; Van H. Manning, director Bureau of Mines, and C. A. Richards, U. S. Department of Commerce; J. D. Cameron Bradley, secretary; E. R. Grasselli, Henry Howard, William H. Childs, Horace Bowker, Charles H. MacDowell, Edward Mallinckrodt, Jr., and J. D. Pennock.

Fertilizer.—Horace Bowker, chairman; Charles H. MacDowell, Charles F. Burroughs, Porter Fleming, W. D. Huntington, William Prescott, Frederick Rayfield and Charles G. Wilson.

Coal-Tar By-products.—W. H. Childs, chairman; J. A. Topping, H. H. S. Handy, C. J. Rainsburg, W. H. Gartley, W. R. Addicks and W. E. McKay.

Alkalis.—J. D. Pennock, chairman; J. D. Ford and C. H. MacDowell.

Acids.—E. H. Grasselli, chairman; Henry Howard, C. Wilbur Miller, J. M. Goetchius and Mr. Cooke.

Miscellaneous Chemicals.—Edward Mallinckrodt, Jr., chairman; George P. Adamson and Adolph G. Rosen-garten.

Alcohol.—Horatio S. Reubens, chairman; Julius Kessler, Carman M. Smith.

Oil.—A. C. Bedford, chairman; G. S. Davison, E. L. Doheny, E. C. Lufkin, John H. Markham, Harry F. Sinclair, J. W. Vandyke.

Cement.—John E. Morrow, chairman; B. F. Affleck, George T. Cameron, Richard Hardy, E. M. Young.

The general chemical committee has established headquarters at Washington in charge of Dr. Wm. H. Nichols, who is devoting all of his time to this work. The committee is co-operating with the Bureau of Mines, the U. S. Geological Survey and the Bureau of Soils in various problems, and all chemical problems are first submitted to this committee. The Manufacturing Chemists' Association of the United States and the National Fertilizer Association have also established offices in Washington in the Woodward Building.

Electrochemists Supporting the Government

The American Electrochemical Society, through its board of directors, has voted to invest \$2,000 from cash in hand in Liberty Bonds—an example which, we hope, will be followed by other scientific and engineering societies.

Presidential Address to the American Iron and Steel Institute

By Elbert H. Gary

Presented at New York City on May 25, 1917

THE UNITED STATES DID NOT SEEK WAR

The people of the United States constitute a peace-loving nation. They abhor war and would go, have gone, great lengths to avoid it. They are considerate, reasonable and forbearing. They are not envious of their national neighbors. They neither seek nor desire anything that belongs to any other country. If they had an advantage over other nations, in any department of human endeavor, they would not unjustly profit by it. Their ambition is to cultivate good will and friendship and their hope is to avoid enmities. Their consistent purpose and effort have been to occupy an independent position among nations, unentangled and uncomplicated with alliances or associations that might interrupt the policy of aiding and never antagonizing others.

These observations are based on history. The record has been written and cannot be changed by any who may impugn the motives or conduct of our people. Such a citizenship when driven to self-defense by a barbarous despotism is apt to be the most terrible, even though civilized and human in its combativeness. This country is largely made up of men and women who came here to live in peace and tranquillity, or the descendants of such; they wish to progress and prosper as the result of privileges which the exclusion of war always permits. The great majority, if not the total, of our inhabitants appreciate what our Republic, with its protective institutions and manifold opportunities, means to every citizen, and with noble impulses they will in every emergency rally around and follow the Stars and Stripes, their emblem of honor, of liberty and of justice.

We did not desire, we persistently and consistently sought to avoid, trouble with Germany and her allies. We had always been the true friends of the Teutons until the ruling powers, for reasons not comprehended by us, forced us into the position of self-defense. We believed, as indeed it was admitted by the invaders, that they were reckless, lawless and cruel in their treatment of their neutral and unoffending neighbors, but as a nation we refrained from interference or even criticism. As human beings we suffered intensely as we learned of the outrages perpetrated upon the innocent victims of force and brutality; and still our nation, not for lack of sympathy, but rather on legal grounds, stood aloof. We were neither indifferent nor selfish, but our President, after full and careful consideration of all the facts and the construction of the rules of international law as determined by the best legal talent, decided he was obligated to remain silent and inactive. For one, I think his conclusions were warranted.

Even after the Central Powers trespassed upon the well-established rights of the persons and property of individual American citizens, our Government was patient and unmoved to action, accepting the excuses and promises of the aggressors. As a nation we exercised more restraint than any large and powerful people ever before practised under provocation so great. Our chief executive indulged the hope for long and weary and suffering days that our entry into the pending war might be avoided. The wish was father to the thought, and this sentiment filled the minds of the majority of the people of the United States.

At last war was forced upon us. The President was compelled to conclude that we were intentionally attacked, that the honor and integrity of our country could no longer be maintained unless the gage of battle

was accepted; and in this decision he was supported by the whole country. His clear, powerful, convincing and eloquent statement of the case and impeachment of the enemy will stand out in history as one of the greatest official declarations and also as fully justified by the existing facts and circumstances.

A COLOSSAL UNDERTAKING

But we have entered upon a colossal undertaking, justified only by the necessities of the case and on the highest moral grounds. It is doubtful if any of us fully realizes the strength of the enemy, even though we know his grim determination. His numbers, his preparedness, resources, devices, creative ability, methods, protective barriers, means of rapid mobilization and transfer of troops and supplies, are further advanced in effectiveness than any other army or armies have ever been. This concentration and perfection of the utilities of military strength should not be underrated. Years of steady, active and studious, though secret, effort have brought about the creation of a giant, powerful, remorseless, conscienceless; and up to the present this kind of a government, armed to this extent, seems to have an abiding conviction that it can overcome all opposition and sooner or later pursue a war of aggression and conquest.

RIGHT MAKES MIGHT VS. MIGHT MAKES RIGHT

And yet, the Allies possess an element of strength not appreciated—if it could under any circumstances be understood—by those who are in control of the armies of the Central Powers. The Allies are contending that Right makes Might; their enemies that Might makes Right. We are of the opinion that we possess a weapon that must prove all powerful. With this as the foundation and inspiration of our armies they are better able to utilize all the forces at their command. It will require time, skill, numbers, sacrifices and large sums of money; but nothing that we do not possess in abundance. For the reason that we are right and the enemy is wrong, we shall probably see other nations of strength and importance, now neutral in attitude, join the Allies, if the war shall be protracted. Some or all of the South and Central American republics, China, Spain, Scandinavia, Holland and Switzerland ought to come in and probably will before the Central Powers are allowed to accomplish what they attempt. These countries could not afford to permit their people to become subject to the dominance of a nation which considers force as the only consideration for aggression and expansion.

With the unprecedented and increasing wealth and the vast resources of the United States she is able to assist materially in providing the financial necessities for equipping multitudes of soldiers from other countries; and if necessary, all these must be mobilized in the defense of a common and righteous cause. And as to equipment, the brains of the Allies, ourselves included, will, in time, be sufficient to match and overmatch the best talent that is possessed by our adversaries after many years of constant thought and study. Among other things it is conceivable that if the Allies had the best and most effective types of aircraft, outnumbering those of the other side five or ten to one, they could obtain and hold control of the air and in this way destroy the productive works, transports of troops and supplies, storage warehouses and other facilities for offensive and defensive warfare of the enemy, and thus materially increase the advantage now held by reason of numbers and resources. We may be sure our experts are giving due consideration to all the possibilities for improved machines and methods.

WHAT WE ARE FIGHTING FOR

What are we fighting for? This question is asked and answered, in one form or another, by millions of people. I give an answer that seems to me to underlie all others: We are fighting to firmly establish and permanently maintain a basis whereby every international question in dispute must be determined in accordance with the principles of justice.

To bring this about, other questions which are obvious, must be determined; but if the above-mentioned basis is secured everything else necessary will have been or will be disposed of.

ALL SHOULD BE WILLING TO SACRIFICE

The task which confronts the country is not confined to the army and navy, although they will be entitled to the larger part of the credit and glory if we succeed. They offer their bodies as a sacrifice, and they must have the undivided, unqualified support of all outside their ranks. The time, money and prayers of all civilians must be given for the soldiers. They bear the brunt; they are the shield for our safety. All of us are fighting in self-defense. This is our land and the flag is ours. The administrators of the country, from President Wilson down, are no more interested than each of us. Life would not be worth living if our flag were to be permanently furled; if our country were subjugated by an alien enemy, especially such a one as we now defend ourselves against.

The pecuniary burdens to be imposed upon us will be very great. We knew in advance such would be the case. We must pay the enormous cost of mobilizing, equipping, supplying and moving our own armies; and we must advance money and provide supplies to our Allies in accordance with their necessities and our resources. We could not decline if we were disposed, for they are now fighting our battles and we are, with them, under the whole burden. We must never falter nor retrace our steps. Wherever or whenever the end is we must press forward with all our strength, might, minds and souls. The more vigorously we proceed within the limits of intelligence, the sooner will the end be reached.

EQUITABLE DISTRIBUTION OF TAX BURDENS

Some of us are complaining or criticising because of the enormous taxes that are likely to be imposed. We are apt to consider ourselves as opposed by the legislative or executive departments of the Government, as if they were partisans, seeking to punish or at least unfairly treat the private individual. We do ourselves an injustice by harboring such thoughts. We can rightfully claim that the burden of taxation be equitably distributed; that all the people, after exempting the necessities of life, shall be compelled to contribute; and that there shall be no waste or extravagance in making expenditures. If possible, taxes ought to be so levied and distributed as to avoid clogging the channels of business prosperity. All this we may properly demand. Equitable distribution is fair and reasonable, and it makes all pecuniarily interested in the subject, including both the collection and the expenditure of the taxes levied. Less than this would tend to create classes—the worst thing for any country.

Now is the time to unite the whole country in a common cause. The soldiers are on a level as they ought to be. All others should be on a level. Classes should be obliterated and also politics, localities and religious differences during war times at least. Opportunity should be open to all; governmental burdens should be borne by all. With such an administration of governmental affairs we should be satisfied, however

severe the drafts which are made upon us or upon the larger interests which we represent.

I lately spent a few days in Washington, and it was my privilege to meet a number of men who in legislative halls or executive departments are serving their country; and it is certain that all are actuated by the motive to fairly represent and protect the best interests of the country and all the people. Individuals are not influenced by politics. There are and will be differences of opinion concerning the various questions presented, as a matter of course, but these will be adjusted and the legislation finally passed will represent an honest endeavor to do what is proper.

GOVERNMENT IS CO-OPERATING WITH BUSINESS

You have heard some criticism concerning the conduct of the Government's business affairs. It has been said that confusion or at least lack of system or co-operation sometimes appears; but it must be remembered that there has been suddenly thrust upon the Government officials an enormous amount of business, extraordinary in volume and character, and the strength and capacity of all are taxed to the utmost and often beyond physical endurance. Besides, rules of law or of departments established to fit other conditions sometimes appear and prevent the exercise of judgment which would bring better results if more latitude were permitted. Officials in Washington are entitled to credit and praise for their management under existing circumstances, and so far I believe there is no just ground for severe criticism.

And then there is a disposition on the part of Government officials to co-operate with the business men in promoting the welfare of the country. This is what all of us have desired and advocated, and now we will probably have as much opportunity in this direction as we have ever desired. Just what will be the result in all the ramifications of the business involved remains to be seen. To the extent that the directors of this Institute have been personally connected with these matters they have been well satisfied, except perhaps as to some of the prices in question.

Mr. B. M. Baruch, chairman Committee on Raw Materials, Minerals and Metals of the Advisory Commission of the Council of National Defense, writing for himself and the Secretary of War, and also representing the Secretary of the Navy, requested your president to act as chairman and to appoint other members of a committee on Steel and Steel Products, to co-operate with the Government; whereupon the matter was brought before the directors of this Institute and such a committee was designated, consisting of the following: Elbert H. Gary, chairman; James A. Farrell, vice-chairman; James A. Burden, E. A. S. Clarke, Alva C. Dinkey, Willis L. King, Charles M. Schwab, John A. Topping.

The general committee has appointed sub-committees as follows:

For Ascertaining Capacities and Supervising Allotments of Orders to Manufacturers.—James A. Farrell, E. A. S. Clarke, J. A. Topping, E. H. Gary, ex-officio.

On Alloys.—J. A. Farrell, E. A. S. Clarke, A. A. Fowler, E. G. Grace, E. J. Lavino, E. H. Gary, ex-officio.

On Iron Ore, Pig Iron and Transportation.—H. G. Dalton, Frank Richards, Harry Coulby, George T. Dyer, W. T. Shepard, A. H. Woodward, Leonard Peckitt, Frank Billings, Amos Mather, secretary.

On Sheet Steel.—W. S. Horner, Charles Hadley, Walter Carroll.

On Scrap Iron and Steel.—Eli Joseph, Samuel Deutsch, Vernon Phillips, Joseph Michaels.

On Pig Tin.—John Hughes, E. R. Crawford, Edwin Groves.

On Tin Plate.—J. I. Andrews, E. R. Crawford, E. T. Weir.

On Tubular Products.—James A. Campbell, chairman; other members to be appointed. Possibly other committees.

The committees meet regularly and are devoting much time to the work involved.

They have, with other work, been engaged in mobilizing the resources of the different producers of steel, such as the Government requires for its purposes, and the statistics are in the possession of the secretary of this Institute.

The Secretary of the Navy submitted a program for 1917 for plates, structural shapes and bars needed for ships, and after considerable negotiation contracts were closed in behalf of the producers on the basis of \$2.90 for plates and \$2.50 for structural shapes and bars. We were of the opinion that in view of present costs and other conditions we should receive larger prices, but in the spirit I have referred to the proposition of the Government was accepted. As costs of production are advancing on account of increases in wages, taxes, prices of certain raw materials, etc., it is expected the Government will be willing to increase its purchasing prices accordingly.

IRON AND STEEL FRATERNITY PATRIOTIC

The Iron and Steel fraternity, represented by this Institute, will be actuated by the highest conception of patriotic duty with respect to the requirements of the Government. We will cheerfully bear our full share of the load which must be carried until there is realized a complete triumph over the hosts of aggressive, desperate and inhuman autocracy. Personal interests will yield to the necessities of the country we love.

Chemical Reactions of Iron Smelting *

By Walther Mathesius

Superintendent of Blast Furnaces, Illinois Steel Company

Throughout the Middle Ages, and as late as the first half of the nineteenth century, blast furnaces were operated the world over with the utmost secrecy. Those skilled in the art carefully guarded their knowledge, surrounding their work with a veil of mystery and handing it down from father to son as a precious tradition.

The first attempt of science to invade this magic circle was, as far as I know, made by Robert Bunsen, who, in 1839, investigated the operation of a little charcoal furnace in connection with his fundamental work on the development of methods for analyzing gases. Since then experimental and operating data relating to the blast furnace process have become available in goodly numbers and a multitude of theories have been advanced, based on such information. In many instances, theories have also been advocated which unfortunately did not have the foundation of such actual experience. In this way volumes have been written, but by far the largest portion of these efforts have been of an explanatory nature, exploring into features of operation which had previously become established through practical experience. Thus it may be stated that, up to the present day, the operating man is still leading in the race between the blast furnace theory and practice, and it need not surprise, therefore, that even to-day blast furnace theorists are being looked

upon by some practical men with a certain lack of esteem.

There are still many adherents to the creed that blast furnace progress must be brought about through practice, leaving it to science to afterward explain the "whys and wherefores." Men of this type overlook the fact that, since the introduction of hot blast, when explanations were sadly lacking for the startling improvement wrought thereby, science has made gigantic strides to close the gap between actual results and their theoretical understanding. The existence of this gap has afforded in the past splendid opportunities for harassing the blast furnace with schemes the futility of which, while theoretically apparent, still had to be proved and paid for by failure in practice. So, as the day draws near when the scientist will wring from the blast furnace its last mystery and will mark it down with mathematical exactness, the theory of the blast furnace process demands of the furnace operator more respect and attention than ever before. While he may not care to follow all the intricate lanes of research and experimentation that have led to the present knowledge, he should have a thorough understanding of the process with which he deals, and it is from his standpoint that I intend to review the reactions of iron smelting as carried on in the blast furnace of to-day.

The task of the blast furnace, while performed as one continuous and interlocking process, may be divided into physical and chemical duties. Among the former the principal items are:

(A) The drying and preheating of the burden materials.

(B) The melting and superheating of the resultant iron and slag.

The chemical duties comprise chiefly the following:

(C) The calcination of the carbonates.

(D) The reduction of the metallic oxides of the ore burden.

The relative importance of the physical and chemical work may be best judged by comparing the amount of energy consumed by each. This can readily be calculated by establishing a heat balance.

An average taken from a number of such calculations covering modern operations shows that, of the total heat introduced into a blast furnace and generated therein, approximately 25 per cent is sufficient to take care of the above-mentioned physical duties, while the chemical reactions require about 60 per cent of the total, the balance being absorbed in radiation losses and heat escaping with the gases. These figures gain particular interest when considering that it is the physical part of the blast furnace work only that is immediately accessible to observation and measurement. It will also be readily understood that any improvement or deterioration in the chemical work must affect the furnace efficiency as a whole to more than double the extent than would a change of equal magnitude in the physical or melting operation. Economy in the performance of the chemical reactions is, therefore, of prime importance to the blast furnace man.

By far the largest part of the blast furnace chemical work consists of the reduction from the ores of the various constituents forming the pig iron. The reducing agent, to bring about this transformation, is furnished by the fuel. From the total amount of coke which is charged into the blast furnace, a certain percentage is always carried out by the furnace gases as coke dust, and another portion is dissolved by the pig iron. At plants using similar raw materials, and under normal operating conditions, the sum of these two items varies only within narrow limits and amounts to a small percentage of the total. It does not decidedly

*A paper read before the American Iron and Steel Institute at New York City on May 25, 1917.

influence the general efficiency of the furnace operation, for which the fuel consumption is the most generally accepted criterion. The latter depends almost exclusively on the mode of gasification and utilization of the remaining major portion of the carbon in the coke. The possibilities in this respect are:

1. The carbon, having passed downward through the furnace stack, reaches the hearth and is gasified there either by:

(a) Combining with the oxygen of the blast at the tuyeres, or

(b) Combining with the oxygen of metallic oxides (direct reduction).

2. The carbon does not reach the hearth, but is gasified above the hearth by reacting with the CO_2 of the furnace gases (premature combustion).

The reactions classed under 1 are normal operating necessities. The reaction (a) creates heat and reducing gas (CO); the reaction (b), while consuming heat, furnishes reducing gas and pig iron product. As long as their sum total and their relative proportion remain within proper limits, these reactions must be classed as desirable, while an excess of either one is superfluous and detrimental.

The reaction named under 2 produces, at a loss of heat, reducing gas only, which, if at all required in the operation of the furnace, could be more advantageously furnished by either reaction 1(a) or 1(b). The premature combustion of carbon must, therefore, in all cases be considered a detrimental reaction.

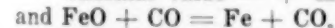
All three of these reactions have one thing in common. They produce carbon-monoxide, the agent by means of which by far the largest portion of the metallic oxides in the furnace burden is reduced to metal. This process, for which the equation $\text{Fe}_2\text{O}_3 + 3\text{CO} = 2\text{Fe} + 3\text{CO}_2$ may serve as an example, is known as "indirect reduction." Its economy is in a large measure responsible for the remarkable efficiency of the blast furnace, which to the present day has not been surpassed by any other metallurgical process.

To substantiate this statement, and to answer several arguments brought forth lately disputing the superior efficiency of the "indirect" over "direct" reduction, the following comparison should be made:

(1) Indirect reduction:



Thermal value = + 426 b.t.u. per lb. of carbon.

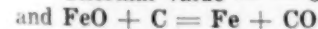


Thermal value = + 351 b.t.u. per lb. of carbon.

(2) Direct reduction:



Thermal value = - 5406 b.t.u. per lb. of carbon.

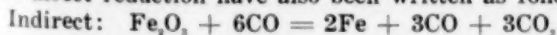


Thermal value = - 5481 b.t.u. per lb. of carbon.

(Thermo-chemical data from J. W. Richards' "Metallurgical Calculations.")

It can readily be seen that, from the thermo-chemical standpoint, the indirect reduction, showing a slight gain of heat, is decidedly superior in efficiency to the direct reduction, with its very material loss of heat. But also with reference to carbon consumption, the indirect reduction has the advantage. While, for the same amount of iron reduced, the carbon requirement is the same in both cases, the indirect reduction utilizes carbon in the form of CO , while the direct reduction consumes carbon, which could be used to better advantage for the generation of heat by burning it to CO with the oxygen of the blast at the tuyeres.

The equations illustrating the comparison of indirect and direct reduction have also been written as follows:



and on the basis thereof it has been stated that, as regards carbon consumption, "direct" reduction was three times as efficient as "indirect" reduction. The errors of this line of reasoning are obvious. There are three molecules of CO introduced into the first equation which are by no means essential for the carrying on of the reaction, in which they are taking no part. The second equation shows as one of the products of the direct reduction, carbon dioxide, which cannot possibly exist in the presence of carbon at temperatures necessary for the direct reduction. Even if carbon dioxide were momentarily produced, it would instantaneously be converted back into carbon monoxide, and in doing so require the additional molecule of carbon, which thus is actually consumed in the process of direct reduction.

Thus it is evident that, from a standpoint of economy, the indirect reduction is more desirable than the direct reduction. The latter is economically permissible only under the following conditions: First, where indirect reduction cannot take place—for instance, when oxides to be reduced are not accessible to furnace gases; and, second, in case the combustion of carbon by the oxygen of the blast at the tuyeres does not furnish sufficient carbon monoxide with which to properly take care of the indirect reduction.

Direct reduction, as mentioned first, takes place in every furnace and is a function of the composition of the iron; in other words, the percentage of silicon, phosphorus, manganese, etc., to be reduced and of the percentage of burden materials, the metallic contents of which are for physical or chemical reasons not affected by the reducing action of the furnace gases. With these conditions given, this phase of direct reduction can be considered as practically constant.

The other case of direct reduction, which is due to scarcity of CO from combustion at the tuyeres, is most likely to be incurred where furnaces are burdened with ores that are easily reduced, and where such furnaces are operated at a fast rate of driving, with high-blast temperatures. Under such conditions, direct reduction will take place to a greater extent the lower the percentage of silicon is in the pig iron. Modern Mesaba practice on basic iron is a good example.

The possibility of a deficiency of reducing gases under the conditions mentioned has frequently been disputed; the chief argument brought forth has been that in furnaces of this class the ratio of CO_2 to CO in the top gases is almost without exception considerably lower; or, in other words, the top gases have a greater reducing power than appears necessary according to the well-known curves of equilibrium as established by Baur and Glaesner. While this is true, it should not be overlooked that the data used as basis for these curves are the results of laboratory experiments with sufficient time allowed for any and all reactions to run through to completion.

Comparing, on the other hand, the volume of gases generated at the tuyeres per minute with the cubic contents of the furnace, and considering at the same time that the stack is not empty but filled to the top with ore, stone and coke, that therefore the only spaces available for the furnace gases are the voids between the solid particles, it is apparent that the time during which the volume of blast entering through the tuyeres can possibly remain in contact with the furnace burden is, at best, only a few seconds. This short interval is all that is available for each molecule of gas to undergo the various reactions which take place between the oxygen of the blast or ore and the carbon of the coke,

*J. W. Richards, "Metallurgical Calculations," pages 252, 253.

between the resultant CO and the metallic oxides of the ore and between carbon dioxide and the carbon.

It is evident, therefore, that the extent to which the various reactions will perform within the blast furnace depends to a large measure upon the reacting speed of which they are capable. The speed of any chemical reaction decreases the closer the relative quantities of the reacting and resulting substances approach the status of equilibrium. Therefore, the various reactions cited above will, within the limited time available in the blast furnace, take place to a larger extent the farther away the relative quantities remain from the status of equilibrium. In other words, in order to be reducing to a degree sufficient for actual practice, the furnace gases must be richer in CO than would be expected from the experimentally determined diagram of Baur and Glaesner.

Thus the possibility of a modern furnace being insufficiently supplied with carbon monoxide through the combustion of carbon at the tuyeres is by no means remote. It is incurred particularly where, with easily reduced ores, high blast temperatures are used, because with higher blast heat the generation of the necessary quantity of heat in the hearth requires less carbon. Theoretically, and keeping strictly within the boundaries of Gruner's theory of the ideal working of a blast furnace, this condition should be remedied by lowering the blast temperature and burning more carbon at the tuyeres. Otherwise, ore must reach the hearth without being properly reduced by the gases, there to be reduced by solid carbon, with a consequent loss of heat to the hearth.

In modern practice this question is solved differently and more economically by permitting direct reduction to take place and at the same time offsetting the entailing heat loss by raising the blast temperature. The limit to which this direct reduction can be carried on depends on the ability to offset the resultant heat deficit in the hearth by higher blast temperature, and on the necessity to keep the top temperature above the desired minimum which is essential for the timely drying and preheating of the ore charges preparatory to their reduction by the furnace gases.

The results obtained may briefly be summed up as follows: Without raising the volume of wind blown, the amount of carbon gasified in the hearth and the weight of metallic oxides reduced per unit of time is increased. The furnace operates at a higher rate of output without requiring additional coke for its hearth reactions. As the cooling and radiation losses per ton of iron are inversely proportional to the rate of production, a saving is effected in this respect, which must ultimately find its expression in a lower coke consumption. As part of the coke carbon is gasified by oxygen from the ore without the addition of nitrogen from the blast, the amount of gas per unit of burden material charged becomes less. The initial temperature of the gas leaving the hearth not being changed, this results in a lower top temperature as well as a lower temperature of the stack. The beneficial effect of this drop in stack temperature on coke consumption and on furnace practice in general will be dealt with later.

Incidentally it may be said that this line of reasoning offers a very plausible explanation for the quite frequently observed fact that in Mesaba furnaces, where high blast heats are available, the burdening of certain percentages of materials not affected by the reducing influence of the furnace gases, such as sinter, results in benefits as mentioned.

Being an endothermic reaction, all direct reduction has frequently been considered detrimental. In reality this can apply only to an excess of direct reduction be-

yond the limits as outlined above. From the same point of view, direct reduction in the hearth has often been confused with direct reduction in the stack, which more correctly should be termed "premature combustion." The latter consumes coke carbon before it reaches the hearth by attacking it and dissolving it in carbon dioxide in the upper regions of the furnace according to the equation $\text{CO}_2 + \text{C} = 2\text{CO}$.

Its influence on the furnace efficiency, both thermal and with reference to carbon consumption, is the same as that of excess direct reduction in the hearth. My previous statement concerning its detrimental character is true the more as in practice premature combustion takes place at the highest rate when any addition to the carbon monoxide content of the gases is least desired.

At temperatures below 900 deg. to 1000 deg. C., premature combustion does not take place to any appreciable extent, as can readily be seen from the curves of equilibrium established by Bondouard. Since its reacting speed grows rapidly with rising temperatures, it is evident that premature combustion must take place in the furnace stack at an increasing rate the higher the temperature of the zone in which the carbon dioxide and the coke come into mutual contact and the longer they remain in contact with each other at temperatures above 900 deg. C.; that is, generally speaking, the higher the average stack temperature of the furnace happens to be. Thus it occurs to a large extent in furnaces making high silicon iron, or furnaces operating on a highly refractory burden, for instance, of magnetite ores. Under such conditions, carbon monoxide is produced over and above the already existing abundance, which has resulted from extensive direct reduction, and which cannot be used to any advantage in the furnace.

In furnaces producing low silicon iron and operating on an easily reduced ore burden, premature combustion may also assume serious proportions, where the rate of driving is too slow and the time is thus unduly prolonged during which carbon dioxide remains within the regions of high temperature in contact with coke. The apparently logical means of counteracting this condition is "faster driving." In many cases this can only be practised after a change in the quality of coke has been brought about.

I refer especially to the combustibility of the coke, the importance of which was first emphasized and termed by Mr. H. A. Brassert in his paper on "Modern American Blast Furnace Practice," read before this Institute in May, 1914. This quality, above all, determines the pace at which a furnace can be operated. Unfortunately, a change of coke structure which tends to improve its combustibility will in many instances simultaneously increase its vulnerability to the solving action of the gases, so that the benefit reached on the one side may be more or less offset by the deterioration wrought in the other direction.

However, modern American coke-oven practice has made enormous strides toward approaching the apparently paradoxical ideal of a coke which with the highest rate of combustibility would combine immunity from solution in furnace gases. This is accomplished by producing coke with an open-cell structure in which the cell walls themselves are amply strong and well protected by a graphitic coating. The results accomplished in this respect are in a large measure responsible for the remarkable improvement of coke practice which has been obtained at a good number of American blast-furnace plants during recent years.

Among the ways and means which counteract premature combustion and are practised aside from faster

driving, I wish to mention one which is now so universally used that its value is often overlooked. I refer to the use of raw limestone as flux. Realizing that it took a considerable amount of heat to calcine the stone, and in an effort to relieve the blast furnace of this duty, the attempt was repeatedly made in past days to charge burned lime in the place of raw stone, but without attaining the expected improvement.

The explanation lies obviously in the fact that the endothermic calcination of the limestone, which takes place about 900 deg. C., is one of the most effective means to quickly bring about a cooling of the furnace gases below the zone of temperature where premature combustion can take place; it appears that thereby, and by simultaneously preventing premature fusion of the ores, which would place the latter beyond the reach of indirect reduction, more coke is preserved and made available for the generation of heat at the tuyeres than is necessary to furnish the heat required for the calcination of the stone.

Since the direct reduction, where practiced within economical limits, increases the ratio of burden to furnace gases, thereby lowering the average stack temperature, it, too, may be termed an effective antidote against premature combustion.

Another most effective means of preventing premature combustion is the application of high blast temperatures. By thus accelerating combustion at the tuyeres, providing for the heat requirements of the hearth with less fuel and a consequently lower volume of gases, concentrating the zone of highest temperature and increasing the ratio of descending materials to rising gases, a decided lowering of the average stack temperature, with correspondingly better fuel economy, can be and has been accomplished. For instance, the blast furnaces at South Works, Illinois Steel Company, being operated according to these principles, have for a number of years, in spite of a severe handicap in the form of irregular coke supply, not for a single month exceeded a coke consumption of 1900 pounds per ton of iron for twenty-one consecutive months. During the year 1916 these same furnaces, with an average age of 331,771 tons per lining, produced 2,066,256 tons of iron on an average coke consumption of 1854 pounds per ton.

From the analysis of the various reactions, it is evident that direct reduction and premature combustion in reference to origin, performance and prevention are two distinctly and entirely different processes, each one independently playing its own important part, in widely varying degrees, in every furnace operation. The only common tie between them is their endothermic character and the fact that they both consume carbon. The sum-total of their carbon consumption represents what is usually called the amount of carbon gasified above the tuyeres. As this carbon is consumed partly by economical and partly by wasteful reactions in ever-varying proportions, it is evident that the relation of this total "carbon gasified above the tuyeres" to the fuel consumption of a furnace cannot possibly have a direct bearing on the economy of operation.

These relations have until quite recently remained obscure, because it was considered impossible to separately calculate direct reduction and premature combustion, while their combined total could be obtained with comparative ease by either subtracting the weight of the carbon gasified at the tuyeres from the total carbon gasified in the furnace, or by directly using the following mathematically developed and therefore universally applicable formula:¹

$$C_x = \frac{3}{4}O_e - \frac{7m}{11 + 7m} (C - C_{Fe}) + \frac{11}{11 + 7m} C_{Cz}$$

in which

C_x means the amount of carbon gasified above the tuyeres,

O_e the oxygen contained in the metallic oxides of the burden,

m the ratio by weight of CO_2 to CO in the top gases,

C the total weight of carbon charged,

C_{Fe} the weight of carbon absorbed by the pig iron, and

C_{Cz} the carbon contained in the CO_2 of burden and flux.

To cite in detail the method of dissecting this " C_x " into its constituents, direct reduction and premature combustion, is beyond the scope of this paper. Suffice it to say that it is done by establishing separate balance sheets for the hearth and stack with reference to heat as well as materials, and therefrom determining the theoretical top temperature for varying percentages of the two constituent reactions involved.² The light which this method of calculation is able to throw upon the economics of furnace operations would seem to justify the belief that it is the solution for the most complicated of blast-furnace puzzles.

To complete this review of blast-furnace reactions, I wish to mention one which in modern furnaces appears only occasionally to any extended degree. This is the decomposition of carbon monoxide according to the equation $2CO = C + CO_2$.

As the speed of this reaction is comparatively low, on account of the existing ratio of quantities involved, and since the zone of temperatures within which it can take place is limited to approximately from 400 deg. to 600 deg. C., the extent of this reaction is, as a rule, slight. Theoretically it must be classed as economical, being exactly the reverse from "premature combustion." However, in practice, when this reaction takes place to any considerable degree, serious difficulties are encountered which make it extremely undesirable. The resulting carbon is deposited on the ores in a very finely divided form and interferes with their permeability to the gases, clogging the voids and causing a swelling of the charges, scaffold formation and all the serious troubles which follow.

When fine Mesaba ores were first used in larger percentages, such difficulties due to excessive carbon deposition were experienced more frequently. With furnace lines poorly suited for the smelting of these fine ores, particularly with the flat bosh angles then in use, irregular working of the furnace with protracted periods of hanging were nothing exceptional. The movement of the furnace charges being brought to a standstill for considerable periods of time, a much larger percentage of the materials in the upper part of the furnace stack was heated to a temperature where decomposition of carbon monoxide could take place, with a corresponding increase in the extent of this reaction as the result. Since then, however, furnace lines have been improved to such an extent as to make operating difficulties from this source a rare exception in Mesaba practice.

It has been observed, too, that a high percentage of hydrogen is often present when carbon is deposited in this manner. The reducing power of hydrogen relative to that of carbon monoxide increases with falling temperatures, and it is reasoned that, with a high percentage of the former, metallic iron in finely divided form is reduced from the ores at exceptionally low temperatures; this metallic iron then acts as a catalytic

¹Professor W. Mathesius, "Investigations Concerning the Blast Furnace Process." ("Untersuchungen ueber die Vorgaenge in Hochofen"), Stahl und Eisen, 1913, page 1467.

²Professor W. Mathesius, "Die physikalischen und chemischen Grundlagen des Eisenhuettenwesens." Spamer, publisher, Leipzig, Germany, 1916.

agent which greatly increases the reacting speed of the decomposition of carbon monoxide.

Excessive hydrogen in the top gases to an extent necessary to bring about such a condition is generally the result of defective apparatus, such as leaky hot-blast valves, tuyeres and bosh plates. If this be the case, the undesirable deposition of carbon can be overcome by removing the source of the hydrogen.

From the standpoint of an operating man, I have attempted to give a brief outline of a subject about which volumes have been written by men of science without ever covering the field. To them belongs the task of further theoretical exploration. We blast-furnace operators must be ready to apply and prove in practice.

Illinois Steel Co.,
South Chicago, Ill.

Buffalo Meeting of American Institute of Chemical Engineers

The ninth semi-annual meeting of the American Institute of Chemical Engineers will be held in Buffalo, N. Y., from Wednesday, June 20, to Friday, June 22, inclusive. Headquarters will be at the Hotel Statler. An interesting technical program has been prepared and part of the time will be spent in excursions. All of the business and technical sessions will be held in the Hotel Statler.

A special program has been prepared for the ladies who will also accompany the men on the automobile trip Wednesday afternoon and on the excursions Thursday and Friday afternoon. The program follows:

WEDNESDAY, JUNE 20, 1917

9.30 a. m.—Address of Welcome. David C. Howard, first vice-president Buffalo Chamber of Commerce.

Business Session.

11.30 a. m.—Reading of Papers. "Some Machinery Employed in the Manufacture of Glue," A. Lowenstein. "Treatment of Sewage by Aeration in the Presence of Activated Sludge III," Edward Bartow.

12.30 p. m.—Luncheon.

1.30 p. m.—Automobile trip around the city and inspection of the Buffalo Foundry & Machine Company.

6.30 p. m.—Dinner.

8.00 p. m.—Reading of Papers: "The Manufacture of Linseed Oil," Glenn H. Pickard. "Trade Wastes Disposal," H. P. Eddy.

THURSDAY, JUNE 21, 1917

All day at Buffalo Canoe Club.

10.15 a. m.—Take excursion steamer from the foot of Commercial Street to Crystal Beach, Ontario. Transfer at the beach to launch "Marion L" arriving at Buffalo Canoe Club about 11.30.

12.30 p. m.—Luncheon. The afternoon to be spent sailing in Abino Bay, swimming, canoeing, playing tennis or taking some of the beautiful walks up through Point Abino.

4.10 p. m.—Leave on launch "Marion L" for Crystal Beach.

4.30 p. m.—Take steamer for Buffalo.

7.00 p. m.—Joint subscription dinner at Hotel Statler for the Buffalo Engineering Society and the American Institute of Chemical Engineers. Addresses by F. A. Lidbury, president of the Buffalo Engineering Society, and President G. W. Thompson of the American Institute of Chemical Engineers.

FRIDAY, JUNE 22, 1917

9.00 a. m.—Business session.

10.00 a. m.—Reading of papers: "Symposium on Potash." "A New Method of Potash Recovery from Feldspar," Prof. J. C. W. Frazer and Dr. E. Miller. "Potash from Waste Liquor of Beet Sugar Factories," H. E. Zitkowski. "The Possibilities of Developing an American Potash Industry," R. K. Meade.

12.30 p. m.—Luncheon.

1.30 p. m.—Automobile ride to Niagara Falls.

3.30 p. m.—Take car for ride around the Great Scenic Gorge Route.

5.00 p. m.—Leave Niagara Falls for Buffalo.

6.30 p. m.—Dinner.

8.00 p. m.—Reading of Papers "Chemical Engineering Aspect of Renovating a Sulphide Mill," H. K. Moore. "Waste Heat Utilization," H. D. Baylor.

American Gear Manufacturers Association Convention

The recently organized American Gear Manufacturers Association held its first convention at the Hotel Schenley, Pittsburgh, Pa., on May 14 and 15, 1917. An interesting program was arranged and elaborate preparations made by the Pittsburgh members for entertaining the visiting manufacturers.

The association has been organized for the purpose of developing, standardizing and improving all products of the gear industry. In view of the present national situation this convention will undoubtedly have a very important bearing on the efforts being put forth by the Government for absolute standardization in all lines of manufacture. The personnel of the membership comprises men who, by reason of the fact that they represent companies making one of the most important items used in automobile construction, may well be said to have been the means of placing the automobile industry in its present pre-eminent position.

The officers of the association are: F. W. Sinram, Van Dorn & Dutton Company, Cleveland, president; H. E. Eberhardt, Newark Gear Cutting Machine Company, Newark, N. J., vice-president; F. D. Hamlin, Earle Gear & Machine Company, Philadelphia, secretary, and Frank Horsburgh, Horsburgh & Scott, Cleveland, treasurer.

The convention was opened Monday, May 14, by F. W. Sinram, president, and the morning devoted to an executive session. In the afternoon S. L. Nicholson, sales manager of the Westinghouse Electric & Mfg. Company, spoke on "The Ins and Outs of an Industrial Organization," and James E. Gleason presented a paper on "The Spiral or Curved Tooth Bevel Gear." On the following morning papers were presented by Frank Burgess on "Job Gearing—To What Extent Can It Be Standardized?" and by William Ganschow on "Advantages of Gear Standardization." In the afternoon George L. Markland discussed the "Difficulties of Gear Standardization."

The entertainment features included an informal dinner at the Hotel Schenley, followed by dancing, automobile trips and a theater party for the ladies, and a bowling contest at the Pittsburgh Athletic Association.

On Tuesday afternoon the delegates visited the works of the Westinghouse Electric & Mfg. Company at East Pittsburgh, Pa., where they witnessed methods of manufacturing bakelite micarta for gears, after which they were the guests of the Westinghouse Company at a dinner in the club rooms of the Pittsburgh Athletic Association.

The Call for the Chemist*

Experiences of the Employment Bureau of the New York Chemists' Club

By Prof. Herbert R. Moody

College of the City of New York

Only the merest fragment of the employment work of the country goes through the Bureau of the Chemists' Club, but it is felt that that fragment is an "aliquot part" of the whole, and hence is an indicator of the trend of demand and of increases or decreases in general or in special lines.

The field of the chemist has developed rapidly. When many of us were graduated, twenty or more years ago, it was the exceptional factory that had a staff of chemists, or even one chemist. When taken through factories, as a student, I recall that I rarely saw more than the crudest sort of control laboratory, and it was fitted with not even all necessities, let alone refinements. Such laboratories as those at the Grasselli Works, the Barrett Company, and the Corn Products Company, to say nothing of such magnificent ones as those of the General Electric Company, were not even dreamed of.

One of our lately deceased college professors told me that the head of one of our greatest industries came to him, certainly not twenty-five years ago, and in course of conversation said that he was disturbed because he had such great quantities of alcohol left from experiments in development work, and that he had no idea how to purify it and use it over again. The impurity being non-volatile, the professor had no difficulty in telling him that it could be purified by distilling the alcohol away from the impurity. "Do you mean to say," said the manufacturer, "that you can sit here in this office and tell me that certain things will happen if you work in a certain way?" "Certainly," said the professor. "Well," said the manufacturer, "if it proves to be as you say I will always run my factory on scientific lines hereafter, and control my work with a staff of chemists." Naturally, it did work as the professor said, and a German was at once imported to establish a control laboratory; and at the time he left, a few years later, I was engaged to take his place as soon as I was graduated. Chance led me, instead, in the following few months, into the teaching profession, but as I was graduated in 1892 the incident is not wholly ancient history. The case is perhaps a little unusual, but it certainly was not unique. You would be amazed if I divulged the name of the company, for it is now one of the greatest industries in the State, even in the country, and it supplies the world with its commodities. The popular mind in those days had not conceived of control chemists, and classed the whole lot of us in with pharmacists, or at best as workers of results far removed from the necessities of ordinary business.

I need go no further with the development of years up to 1913. You are all familiar with the accomplished fact of the acceptance of the chemist as a by no means humble cog in the industrial wheel, but recent years have been unusual, and hence of exceptional interest.

"No conscientious reporter can yet say," writes Mr. Wm. Hard in a recent magazine article, discussing social changes due to the war in Europe, "whether it is the greatest war of history by reason of being the most destructive and desolating, or the greatest war of history by reason of being the most creative and fruitful." This is a new view to take of war. Is it possible that there can be liberalizing influences at work that take their inspiration from a condition in itself the very antithesis of tolerance and liberalism? This is a ques-

tion worth keeping before us in any consideration of the relation of this country to the struggle in Europe.

But certain it is that the chemical industries have responded to the impulse. No need for me to rehearse to this group the increase in volume of old processes and the establishment of processes entirely new (at least in this country). To maintain these processes, research and control men have been needed, and the result has been that chemistry has become a more desirable and lucrative profession. The colleges have felt the urge, and classes have often doubled, sometimes quadrupled, so the increased demand is easily met by the new supply.

The chemist with special training has resulted in the establishment and rapid growth of the club's employment bureau. Formerly handled almost entirely by the chairman of the club committee in his own office, it has in a few years come to occupy two offices upstairs, and requires the entire time of four efficient young women to the ability of whom the writer takes this occasion to bear testimony. The work being only an avocation to him, without such intelligent helpers he never could have established nor maintained such a standard as has been reached.

The club's committee represents the bureau in Lowell, Brooklyn, Niagara Falls, Pittsburgh, Savannah, St. Louis, Denver, Chicago and Los Angeles. Thus our aid is secured by employers and employees in most of the great centers. We could, however, handle more calls than we receive, and all employers here present will do us a favor if they will let us know their needs. The increase in geographical scope of the work of the bureau is most interesting. While a large part of our calls are naturally from the metropolitan district, yet we are in receipt of calls from all over the world. We even hear from such unlikely places as Siberia, and other parts of Asia, South America, Mexico and Europe. We have recently placed a man in the Dutch East Indies.

Of course, calls from such places, although carrying excellent salaries, are hard to fill, since very specialized qualifications are insisted upon. The bureau is in great need of a far longer list of specialists. It hopes that any of this audience, even though they may in no sense "be looking for a position," who are specialists in any line will record such specialty with the bureau. It may prove to be of great advantage to all concerned. This tremendous increase in the call for the man with special experience is one of the features of the present expansion. Daily we are obliged to hopelessly reply that we have no man with such experience on our lists. There must be such men in the country, and we wish that you would let us know what your specialties are. A call for you may not come at once, but when it does we need you badly. Such calls are often for consultation only, and could be handled in addition to the man's regular work. Figures showing the increase in calls for men specializing in work which could be classed as "organic" are interesting. Calls for inorganic men remain rather constant, but in four years the organic men have come to receive three times as many calls. From 1913 to 1916, inorganic calls were 161, 98, 149, 136, whereas for the same years organic calls were 46, 65, 141, 158. As said at the beginning, bureau calls, of course, represent only a minute fraction of the vacancies of the country, but it is felt that changes shown by them are representative of the country. Therefore, the following may be taken as showing the immensely greater demand for men of our profession. I have taken the last four years as illustration.

In 1913 we had calls for	275 chemists
In 1914 we had calls for	358 chemists
In 1915 we had calls for	707 chemists
In 1916 we had calls for	841 chemists

*A paper read before the New York Section of the American Chemical Society, May 11, 1917.

If only at the same rate as the first four months of this year (1917) we shall exceed the figure for 1916. Undoubtedly, in light of present events, the call will increase in the remaining eight months. The bureau is able to provide satisfactory candidates for about 50 per cent of the positions reported to it. It could raise this percentage well on toward 75 per cent if more specialists would register. It is with greatest difficulty that we find men to take positions involving works control with heavy acids, wood products, coke-oven by-products, textiles, dyes, rubber, soap, uncommon pharmaceuticals, perfumes, essential oils, storage and dry batteries, electrochemical products, hydrogen peroxide, etc., etc. We would be glad to know of men trained and experienced in all these lines.

The following table gives interesting figures showing the increase in calls:

	1913	1914	1915	1916
Laboratory	189	179	407	481
Works	39	70	142	162
Research	18	26	36	44
Teaching	24	35	52	23
Stenographers	5	3	6	3
Salesmen	4	8	6	11
Advertising men	1	0	0	3
Translators	6	4	3	3
Miscellaneous	5	19	24	18

It is oftentimes supposed by those unfamiliar with the work of the bureau that calls for good salaried positions are infrequent. To such persons the following tables are of interest.

	1913	1914	1915	1916
Calls at salaries under \$700.....	26	47	65	54
From \$700 to \$900.....	62	44	100	103
From 900 to 1,200.....	82	93	198	125
From 1,200 to 1,500.....	56	77	128	145
From 1,500 to 2,000.....	44	71	120	126
From 2,000 to 3,000.....	13	15	46	63
From 3,000 upwards.....	1	3	17	17

In this table is also shown the increase of higher salaried positions.

Tables showing calls for chemists would not be complete if reference were not made to calls for women. Since woman in industry has become an assured fact it is interesting to see if the woman chemist increases in numbers as fast as those in other professions. It certainly seems as if she did not. There is a distinct prejudice to hiring women in works laboratories, and the bureau rarely places one there. It is a prejudice which will surely be overcome, and ought to be overcome faster than it probably will be. The supply is fairly constant, and is growing, and will grow faster if at all encouraged. The bureau is constantly in receipt of letters from individuals, women's chemistry clubs at colleges, and from the colleges themselves, asking what the outlook for the woman chemist is, and whether we advise the emphasizing of such work for their girls.

My personal experience is that women for laboratory work are the equal of men, and in many cases show superior qualities of neatness and order, regularity of work, and freedom from distraction from duty. We always urge their employment wherever the isolation of the factory or the class of men employed in the works does not make the presence of women undesirable. Nearly every factory has women in its offices, however, so there is usually no reason why they should not be in its laboratories.

The bureau figures on the subject are as follows. Attention is called to the great discrepancy between the number of places which women *could* fill and in which we *did* place them.

	Total Calls	For Women Only	Men or Women	Not Laboratory Work	Women Placed
1913-1914.....	643	15	7	9	10
1915.....	707	8	8	6	5
1916.....	772	10	6	6	4

Generally everyone thinks at once of dye work and work on explosives if he begins to picture the increase in chemical industry. I have, therefore, taken a few facts and figures regarding these two industries which trace development.

The height of demand in explosives work (beginning in 1914) came in the winter of 1915. The calls came from new companies or old ones enlarging their works. The demand has slackened to a very large extent. Many of the men who took these positions thought it was an industry about to contract in volume and so have left for more permanent lines of work. Calls now are mostly to fill the vacancies caused by the departure of these men. Of course, the recent declaration of war in this country has changed this situation, but its effect has not yet been felt in the Bureau. The height of the demand for men in the dye industry was felt in winter of 1915, having reached its maximum quicker than that of the explosives industry, since we had no calls for dye men during 1914.

Calls in these industries varied since routine men were asked for in the explosives even from the start. In the dye work, however, the calls at first were entirely for highest-grade men, specially trained in this work. There were practically no such men available, and although \$5,000 up was offered there were no possible candidates. These specialists were non-existent in 1914 and had to be developed. The demand was for men "with experience," generally specified as "with experience in this line in Germany." Since such men did not materialize, substitutes have been found in men of foreign training experienced in organic pharmaceuticals or in textile dyeing industry.

It was noticeable that the demand was at both extremes and little "in the middle." That is, it was either \$5,000-up men or \$720-\$1,800 men. There was little chance for men good in other lines, but who had not this special experience and yet who had commanded salaries of \$2,000-\$3,000. That is, a large number of college instructors, etc., who thought there was a great opportunity for organic research along such lines, and who desired to make the change, found no opportunity calls come in. There was a time in those two years when manufacturers were throwing money into such developments with the hope of large returns and wanted men who could at once, with no experimentation, build and operate these unusual plants. This period was followed by one demanding groups of six or eight or more to do routine and research. Then this stage was followed by one in which contracts expired or companies went to the wall for one reason or another, until to-day the companies still existent are fairly stable, although evidence is not lacking of internal crumbling in some of them. At the present minute they are apparently not enlarging, and calls are only to fill changes in personnel.

It is interesting to note the increase of metallurgical work. Both in Canada and in the United States we note increased calls in this field. These are mostly along routine lines, but a marked upward movement in iron, steel, brass and copper is observed. No increase has come in calls from electro-metallurgical plants nor electrolytic industries.

The trend toward industry is shown in the teaching profession. Not only are young as well as seasoned instructors leaving or hoping to leave teaching work, but this year's graduates will not look at a teaching offer. Even a teaching fellowship does not interest him.

This unrest is noticeable not only in the ranks of teachers, but is seen in those already in industry. Everyone seems to think it is "a good time to change," and is looking for big results "somewhere else." We are besieged with requests for change of position.

Lastly, the most interesting phase is the increased idea of value of service held by so many of our men. Two years ago many of our men thought they were doing very well with the salary they received and prospects of increase. Now, as previously said, most of them are "looking for something better." A typical case is that of a man only ten months out of college who was getting \$120 a month in a position in which we placed him. He has just written in that he is to leave and wants a higher paid position. It seems as if the high salaries paid in munition and dye works account for this feeling even more than the increased cost of living. Even raw graduates expect far greater salaries at the start of their careers. Two years ago \$55 to \$60 was considered by the men as a reasonable starting salary; now they state \$80 to \$90 as their minimum. Even non-graduates, just Sophomores and Juniors, expect to get \$75 for their half-trained services.

As the concluding evidence of growth or perhaps lack of growth, in one direction let me give figures regarding plants which we have observed now to employ chemists which have not previously found their services necessary: This figure astounded me, as I supposed investigation would prove it to be a far larger one. It seems to be the case, however, that previous to present development nearly all manufacturers already employed chemists or that present development has affected only such previously established industries as were already progressive enough to employ modern control methods. Be the reason one or the other, it is true that out of 1200 positions reported to us in fifteen months just passed, but five came from employers who were established previous to 1915 and yet who had never before engaged chemists.

The Cracking of Petroleum in the Liquid Phase*

By Roy Cross

In the study of the temperature-pressure decomposition relations of the hydrocarbons composing petroleum, it is necessary to confine all substances in a closed vessel with the vapor in equilibrium with the liquid in order to observe the conditions under which transformations take place.

In the application of heat to such a system it is most convenient to apply this heat to the liquid phase. In so doing, the temperature of the oil and the pressure developed are correct indices of the vaporizations and transformations within the system.

The amount of pressure developed up to a certain point is directly proportional to the temperature. At this certain point, however, the pressure is no longer proportional to the temperature, but increases at a much greater rate than the increase of temperature and the pressure under certain conditions even continues to rise with no increase in temperature and with an actual fall of temperature.

The rate of development of pressure depends upon the actual temperature of the confined oil, and also depends upon the character of the oil under treatment.

The certain temperature at which the disproportionate rise of pressure takes place is not absolutely definite, as it seems to be much lower when the rate of heating is low and much faster with a high rate of heating or a high temperature of oil.

In fact, if the temperature of the oil is carried to 400 deg. C. or above, the decomposition will take place

with almost explosive violence even without further application of heat.

This kind of decomposition is undesirable on account of the excessive production of non-condensable gas, though this gas is largely of the paraffin series of hydrocarbons.

Furthermore, there is not so satisfactory a yield of the gasoline hydrocarbons.

With a slow rate of heating, there is a distinct decomposition at 300 deg. C., and there is possibly some cracking below this temperature.

With a hot flame applied to the container, the residual heat after removing the fire has some effect, but it has been observed that there is additional development of pressure even after the container itself has cooled below the temperature of the oil.

There seems to be little doubt that a temperature of cracking below 400 deg. C. is necessary for a first-class product, and that the lowest temperature possible is to be used.

It would be highly desirable to find a catalytic agent which would sufficiently accelerate the conversion at 300 deg. C. or lower to make such a temperature commercially usable. This would greatly lower the pressure needed, as gasoline at 400 deg. has a vapor pressure of over 50 atmospheres while at 250 deg. its vapor pressure is below 30 atmospheres.

A considerable amount of the pressure developed in a closed system is due to the non-condensable gas as is evidenced by the fact that in a typical conversion 8 atmospheres of pressure remained when the container was cold and when it was originally half filled with mid-continent residuum of 26 deg. Baumé gravity. In the same conversion 40 per cent of 58 deg. Baumé gravity gasoline was produced based upon the treated oil.

In cases where the pressure developed with excessive rapidity there was slightly less gasoline and more permanent gas.

A very good measure of the quality of gasoline produced is the ratio of the specific gravity to the boiling temperature. A very low ratio is an indication of gasoline of high hydrogen content, of good quality and of low refining loss.

Gasoline made by confining the heavy hydrocarbons at a temperature of 380 deg. C. gives gasoline having as good a ratio of gravity to boiling point as natural gasoline. Olefines have a slightly higher ratio than paraffin hydrocarbons, and naphthenes and aromatics have a much higher ratio.

Gas oil cracked in the vapor phase without pressure in muffles at a temperature of 600 deg. C. gives naphtha composed largely of olefines and aromatic compounds and with a large amount of permanent gas of the illuminant type.

Based upon laboratory experiments on cracking petroleum, both in the liquid phase and in the vapor phase, and based upon commercial size tests in the liquid phase at low temperature and the vapor phase at 600 deg. C., the following advantages seem to be shown in the application of the heat to the liquid phase:

- (1) A product of superior quality is obtained.
- (2) A higher yield of refined gasoline is to be had.
- (3) There is a selective action on the oil or heavy portion of the petroleum with freedom from further cracking of the portion in the vapor phase.
- (4) There is automatic removal of the gasoline from the sphere of action as fast as it is formed.
- (5) There is high economy of heat.
- (6) There is deposition of the carbon in the suspended condition in the oil and not on the walls of the heating tubes.

*A paper presented in the Petroleum Session of the Kansas City meeting of the American Chemical Society.

(7) There is high oil capacity with small dimensions of plant.

(8) There is perfect control of temperature.

(9) There is rapid and complete absorption of heat from the furnace.

(10) There is possibility of operating either intermittently or continuously.

The disadvantage in cracking the oil in the liquid phase is the high pressure required for maintenance of equilibrium and the attendant danger of failure of apparatus.

The disadvantages of cracking heavy petroleum in the vapor phase are:

(1) The poor quality of the product.

(2) The over-production of permanent gas due to non-selective action.

(3) The deposition of carbon on the walls of the heating tubes.

(4) The comparatively low yield of refined gasoline.

(5) The high temperature required to get capacity on account of the necessity for quick reaction.

(6) The danger of local over-heating on account of the low specific heat of the vapor.

(7) The large heating area and plant dimensions for any great capacity.

The advantage of cracking by heating the vapor is that in the absence of pressure there is less danger of destruction apparatus with explosive violence.

In consideration of the temperatures at which cracking of oil takes place and in consideration of the vapor pressure developed by gasoline and other light hydrocarbons at the temperature of cracking, it appears that the optimum method of operation for converting heavy oil to gasoline in the vapor phase is to maintain a pressure of 30 atmospheres or 450 lb. per square inch and a temperature of not over 400 deg. C. If it were possible to lower the temperature for rapid conversion by means of a catalytic agent, then, of course, the pressure necessary for operation would be considerably lowered. In practice, heating would be done in a tube furnace with rapid circulation of oil from and to a vapor chamber which also serves as a chamber for the separation of carbon.

Various mechanical arrangements, of course, could be used that would be satisfactory. The tubes should be so designed that they will sustain the pressure at the actual fire-box temperature used regardless of the tem-

perature of the oil. Assuming that a temperature of 800 deg. C. is attained in the fire box, then the tubes should be of 4-in. inside diameter and $\frac{1}{2}$ -in. walls. This would give a factor of safety of over 200 per cent, since steel at a temperature of 800 deg. C. has an elastic limit something greater than 5000 lb. per square inch. At 800 deg. C. such a tube would fail at 1250 lb. pressure.

The design of the parts not exposed to the heat of the furnace would be comparatively simple, since they would be subject only to the temperature of the oil or vapor which in no case should exceed 400 deg. C.

In Fig. 1 is shown the relation of the temperature to the development of pressure in cracking mid-continent residuum. Curve No. 1 shows the development of pressure from 26 deg. gravity residuum beginning at 210 deg. C., and the pressure then rising in direct proportion to the temperature up to 290 deg. C., when there is an upward turn of the curve which at a temperature of 320 deg. C. increases without any further increase of temperature. This curve represents the cracking with very slow application of heat and shows the low temperature at which cracking can take place. Curve No. 2 shows the effect of very rapidly heating practically the same mid-continent residuum. In this curve the pressure began to develop at 200 deg. C., and was directly proportional to the temperature up to 345 deg. C., at which temperature the pressure began to develop much more rapidly than the rise in temperature, and when the temperature of 395 deg. C. was reached all application of heat was withdrawn while the pressure continued to develop and with a fall of temperature. Whenever a temperature of 400 deg. C. or slightly above is reached the cracking takes place with almost explosive violence, and with the high temperature the product is not so good in odor and there is more non-condensable gas. The cooling curve comes back to a pressure of about 15 atmospheres, with the pressure in direct proportion to the temperature, but below this the non-condensable gas has its effect, and with a residual pressure of about 8 atmospheres when cold.

Fig. 2 shows the heating curve and cooling curve of mid-continent residuum as to the relation of the temperature in degrees Centigrade and the pressure in atmospheres, and also shows this same relation of the vapor of gasoline and kerosene. It is quite clear that the pressure at which gasoline and kerosene are produced is the point at which the gasoline or kerosene curve intersects the minimum cracking temperature

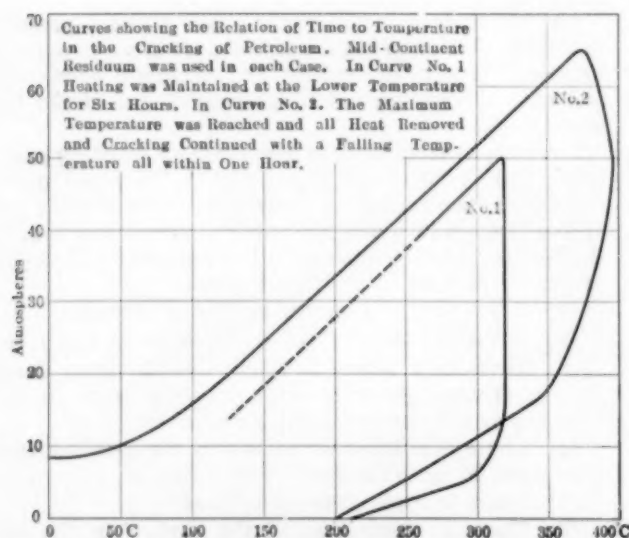


FIG. 1—PRESSURE-TEMPERATURE CURVES OF MID-CONTINENT RESIDUUM

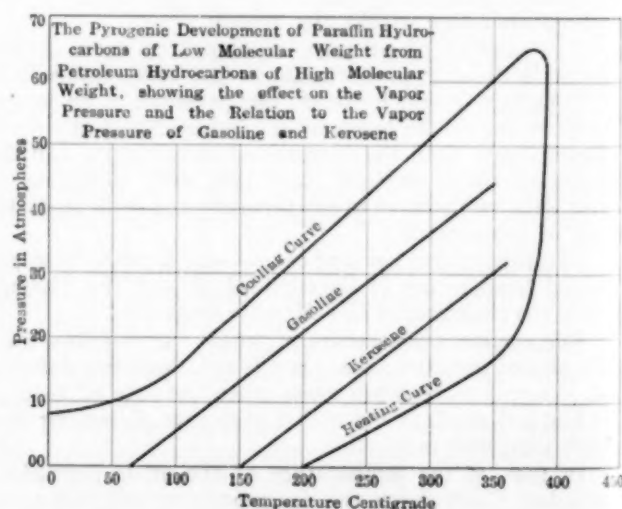


FIG. 2—HEATING AND COOLING CURVES OF MID-CONTINENT RESIDUUM

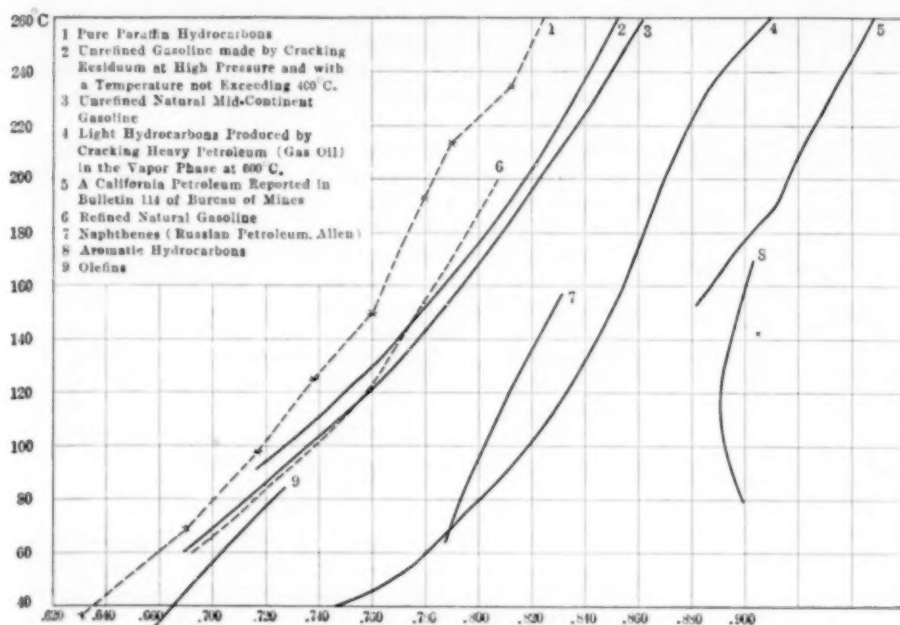


FIG. 3—SPECIFIC-GRAVITY, BOILING-POINT CURVES

line. If the minimum cracking temperature is 300 deg., then there would be gasoline vapor in equilibrium with the liquid phase at a pressure of about 36 atmospheres and with kerosene at about 22 atmospheres. An intermediate point, probably about 30 atmospheres, would be then the best pressure at which to continuously distill gasoline in order to maintain the liquid phase and while heating the liquid phase.

Fig. 3 shows the relation of the specific gravity to the boiling point of various hydrocarbons obtained from petroleum. Curve No. 1 shows the boiling temperatures of the pure paraffin hydrocarbons. Curve No. 2 shows unrefined gasoline made by cracking mid-continent residuum in the liquid phase at high pressure and with a temperature not exceeding 400 deg. C. Curve No. 3 shows unrefined natural mid-continent gasoline. Curve No. 4 shows the light hydrocarbons produced by cracking heavy petroleum gas oil in the vapor phase without pressure and at 600 deg. C. Curve No. 5 shows the California petroleum reported in Bulletin 114 of the Bureau of Mines, which is peculiar on account of the exceedingly high ratio of the specific gravity to the boiling point and very nearly coincides with the curve for aromatic hydrocarbons No. 8. Curve No. 6 shows refined natural gasoline with an end point of 200 deg. C. Curve No. 7 shows naphthenes as given by Allen for Russian petroleum. Curve No. 9 shows olefins. Special attention is called to Curve No. 2, which shows as low a ratio of gravity to boiling point as high grade natural gasoline. This ratio is practically unchanged by refining with sulphuric acid, as the refining loss is almost negligible. Curve No. 4 represents hydrocarbons

composed largely of aromatic compounds, olefins and paraffins being practically 50 per cent aromatic compounds. This in a general way shows the tendency of high temperature and of the vapor phase to produce hydrocarbons having a very high ratio between the specific gravity and boiling temperature.

Fig. 4 shows the effect of high temperature on the elastic limit of steel. From the standpoint of the cracking in the liquid phase the entire success depends upon the margin of safety allowed in the design. At a temperature of about 350 deg. C. there is a very rapid decline in the strength of steel, but this rate is less rapid at an ordinary fire-box temperature, which in cracking in the liquid phase will not exceed 800 deg. C. This will plainly allow the use

of a 4-in. inside diameter cracking tube with a half-inch wall, provided, of course, there are no other elements entering into the deterioration of the steel.

Notes Upon the Hydrometallurgical and Electrolytic Treatment of Zinc Ore*

By E. E. Watts

The war has given a great impetus to the zinc industry, and much attention has been directed to the treatment of complex ores by hydrometallurgical and electrolytic processes.

The possible methods of treating zinc ore for the recovery of zinc may be classified as follows: (1) smelting, (2) chemical, (3) electrolytic, (4) electric smelting.

Smelting includes the standard distillation method for high-grade ore. Distillation may be preceded by igneous concentration.

Chemical methods include various processes for the production of zinc salts or zinc oxide, possibly followed by smelting for the recovery of zinc.

Electrolytic methods include processes for the recovery of zinc by electrolysis, in which electrolysis may be preceded by preparatory chemical or igneous processes.

Electric smelting includes methods for producing zinc, zinc oxide, or zinc dust, by the use of the electric furnace.

EXPERIMENTAL WORK

In 1912 and 1913, at the School of Mining, Kingston, the writer experimented with zinc ore from the Sullivan Mine of Kimberly, B. C. The ore was a dense complex sulphide, of which the chemical analysis was:

Zinc	31.2%	Insoluble	12.8%
Lead	10.1%	Lime	Trace
Iron	13.4%	Sulphur	31.0%
Silver	3.1%		

Microscopic examination showed that the diameters of the mineral particles were as follows:

*A paper read at the Kansas City meeting of the American Chemical Society.

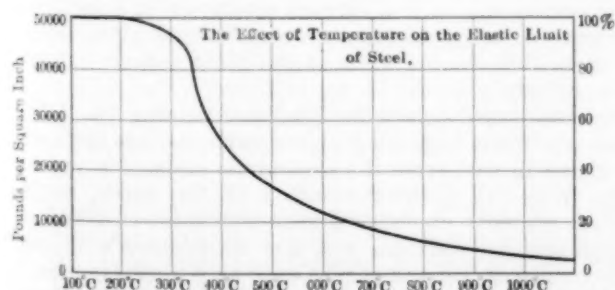


FIG. 4—ELASTIC LIMIT AT HIGH TEMPERATURES

Blende	0.20 mm. to 0.05 mm.
Galena	0.20 mm. to 0.05 mm.
Pyrite	0.10 mm. to 0.025 mm.

The microscopic examination precluded the possibility of a mechanical concentration, and hence left igneous or hydrometallurgical processes as possible means of treatment.

Preliminary roasting and lixiviation tests indicated that a sulphurous acid treatment of the roasted ore would give interesting results. The conditions were worked out for obtaining an 87 per cent zinc extraction by a sulphurous acid leaching, and attention was directed to the recovery of zinc from the resulting solution of zinc bisulphite. The conditions were determined for the precipitation of zinc monosulphite from the zinc bisulphite solution.

The Zinc Commission¹ has pointed out that zinc smelting in Canada, even for high-grade ore, is a very doubtful commercial enterprise. It would, therefore, appear that a sulphite precipitate must be roasted to oxide and exported, or the zinc must be recovered from it in some other way than by distillation.

Tests were conducted to determine if it was possible to obtain metallic zinc by the electrolysis of solutions of zinc bisulphite. The deposition of sulphur and zinc sponge, and the evolution of hydrogen sulphide made this electrolysis impossible. Then attempts were made to obtain metallic zinc by electrolysis of solutions of zinc sulphate to which zinc sulphite precipitate was periodically added. The additions were made to the bath and to muslin bags at the anodes, but the tests showed that in the presence of sulphurous acid or zinc sulphite successful electrolysis was impossible.

Tests were conducted in which the zinc sulphite precipitate was first roasted to oxide before charging at the anodes in a zinc sulphate electrolyte. Successful results were obtained. The zinc deposited in a good plate, and the electrolyte was maintained by the addition of the roasted sulphite. To free the bath from particles of precipitate that might attach themselves to the deposit, to place the roasted precipitate at the point in the bath where the sulphuric acid is regenerated by the electrolysis, and to decrease, if possible, the decomposition voltage by allowing the roasted precipitate to act in part as anode, the crude zinc oxide obtained by roasting the zinc monosulphite precipitate was placed in bags at the anodes of the electrolytic cell.

From the foregoing experiments the following conclusions were deduced:

1. Successful electrolysis is impossible in the presence of sulphurous acid or zinc sulphite.
2. Successful electrolysis is possible with an electrolyte of zinc sulphate to which zinc oxide, prepared in any suitable manner, is charged to compartments surrounding the anodes of the cell.
3. Lead forms a satisfactory anode, and copper, zinc and aluminium form satisfactory cathodes.
4. With current densities of from 2.5 amps. per square decimeter to 4.5 amps. per square decimeter, a current efficiency of approximately 100 per cent can be maintained.
5. Depending upon the current density, the voltage varies from 3.5 to 6 volts.
6. The extraction of zinc from zinc oxide varies from 95 to 100 per cent.

The process, as outlined, was patented, and was developed for the treatment of high-grade zinc ore. The process has been referred to as the Watts Process.

The high-grade zinc product for charging to the electrolytic cells may be roasted zinc concentrate, im-

pure or refined zinc oxide, or zinc dust. The advantages of such a treatment are:

1. The solution is kept small in bulk, and the solution and tanks serve at once for leaching the ore and for electrolysis.
2. The acid generated at the anode is immediately used up at the point at which it is generated, and at the point where it is most concentrated and hence most active. Thorough extraction is thereby obtained.
3. The bath is automatically kept at constant composition and purity, zinc goes into solution with the relative exclusion of impurities.
4. The zinc content of the solution is kept constant, and high-current efficiency is therefore maintained.
5. The conditions are fulfilled for obtaining a good cathode deposit.
6. The residues from electrolysis may be further treated for the recovery of other metals.

LARGER SCALE—EXPERIMENTAL WORK

The writer became connected with the Weedon Mining Co., and in March, 1915, carried on experimental work in the metallurgical laboratory at McGill University. Various ores were treated, including ore from the company's mine at Notre Dame des Anges, Quebec, zinc oxide from Leadville, Colo., and ore from Mineral Point, Wis. The work served to develop a wooden electrolytic tank, asphalt lined, and antimony-lead anodes and aluminium or copper cathodes. The anode compartment consisted of a wood and canvas box which surrounded the lead anode.

In August, 1915, work was started on an experimental plant at Welland, Ont. The equipment consisted of a 100-kw. motor-generator set, a blower for air agitation of the anode solution, a vacuum pump for filtering, 28 electrolytic tanks 3 ft. x 3 ft. x 4 ft. deep, sump tanks, storage tanks, and filter tanks. Standard cast-iron centrifugal pumps were used for handling solutions. An Abbe ball mill was used for grinding.

Roasted Joplin concentrate assaying 60 per cent zinc was the first ore treated at the plant. It was necessary to charge this ore to the electrolytic tanks in the form of a paste, and a small pebble mill was used for mixing the ore into a paste with zinc sulphate solution. From the mill it was fed by hand to the anode compartments at six-hour intervals. With oxide it was possible to use dry charging, and in both cases air pipes in the bottom of the compartments kept the ore particles in suspension.

In the first trial run in the plant an unsuccessful attempt was made to reverse the position of the compartments. Air agitation was used in the bottom of the tanks, and the compartments surrounded the cathodes instead of the anodes. Seven anodes were used per tank. It was found that the solutions would not transmit 800 to 1000 amperes without overheating.

With two anodes per tank, with the compartments surrounding the anodes as in the original experimental tank, and with a current of only 950 amperes per tank corresponding to a current density of 12.5 amperes per square foot, good results were obtained. But, operating in this manner reduced the plant capacity about 70 per cent.

Several expedients were tried for keeping the solutions cool when employing higher currents, but the heat resulting in part from the electrolytic resistance and in part from the chemical reaction at the anode, made higher currents impractical with this form of tank.

Considerable difficulty was also experienced with the compartments, for the canvas used as a diaphragm material developed into a serious weakness, and required constant attention and repairs. Promising preliminary

¹Report of the Commission of the Investigation of the Zinc Resources of British Columbia.

tests were made upon other diaphragm materials, but this investigation was not completed.

Considerable trouble and loss was caused by the tank construction, and great difficulty was experienced in obtaining an absolutely reliable and tight tank. In fact, it was necessary to replace the original tanks, and the new tanks were made with approximately the same cross section but considerably shorter, in order to accommodate two or three anodes. It was possible, therefore, to run two series of tanks in parallel and thereby to double the plant capacity.

The melting of the deposits, which were stripped every two to six days, caused trouble for a time. An attempt was made to strip copper cathodes by dipping them into a bath of molten zinc. Loss by dropping damage to the cathodes and copper entering into the zinc, made this impractical. Melting was thereafter done in a gas-fired crucible tilting furnace. A flux of sal ammoniac was found to be advantageous.

In general, the laboratory experimental results were attained, but our operations did not permit of a sufficient margin for profit. The company did not see its way clear further to perfect the details of the process on a large scale, so the plant was closed in August, 1916.

When producing zinc at the rate of 8000 lb. per month, or at the rate of 270 lb. per day, the cost of producing zinc was as high as 18 cents per pound plus the cost of the ore.

On the basis of a steady production of 60,000 lb. per month or 2000 lb. per day, the writer estimates that the cost of producing zinc electrolytically should be 4 cents per pound when power is available at \$14 per horsepower year. Costs would be distributed as follows:

	Cents per Lb.
Crushing, pumping, filtering and purifying.....	0.6
Electrolysis, including power, labor and repairs.....	2.3
Melting.....	0.8
General.....	0.3
Total operating cost.....	4.0

In a large plant the above costs would be considerably reduced.

Thirty tons of 60 per cent ore were received at the plant, as well as 10 tons of oxide that was manufactured from the ore mined at Notre Dame des Anges, Quebec. About 30,000 lb. of zinc were produced, which averaged 99.95 per cent zinc.

CONCLUSION

The work showed that it was possible to operate upon a commercial scale, but it showed that weakness existed in the diaphragm material, and that many of the mechanical details could be improved. The process possessed advantage over other processes with respect to extraction, current efficiency, and necessary purity of the electrolyte, for good results were obtained in solutions in which ordinary electrolysis is impossible. With a satisfactory diaphragm it seems probable that a higher acid electrolyte could be used with a correspondingly high current density, and it is probable that future development will be along this line.

In conclusion, I wish to acknowledge my indebtedness to Prof. S. F. Kirkpatrick of the School of Mining, Kingston; Dr. Stansfield of McGill University, and Mr. L. D. Adams, president and general manager of the Weedon Mining Company.

Trail, B. C.

Mining Exchange at Fresno.—A Mining Exchange for selling mines and mining stock has been opened in the Trust Company Building at Fresno, Cal. John A. New is secretary-treasurer and J. Duke Murray is manager. The need for this exchange has long been felt in this district.

Note on the Thermocouple Nichrome-Constantan*

By R. W. Woodward and T. R. Harrison

During the course of an investigation at the Bureau of Standards of the temperature distribution in cooling rails of various sections it became necessary to use thermocouples under unfavorable and peculiar conditions. These required that the couples be small and remain constant in their calibration while inclosed to a depth of 4 in. in holes of 6 mm. diameter in steel at 1000 deg. C. in an oxidizing atmosphere without the use of porcelain insulators in the usual manner. Couples of 0.1 mm. platinum, platinum-iridium and of No. 16 B. & S. gage iron and No. 20 B. & S. gage constantan¹ wire were tried and found not to fulfill the requirements of constancy.

After a trial of several base-metal elements a couple of No. 18 nichrome² and No. 12 constantan was found to answer the purpose very satisfactorily. These wires had a single asbestos wrapping and were further protected by covering with a thick mixture of kaolin and sodium silicate, winding with asbestos cord and again smearing with a thinner mixture of kaolin and sodium silicate.

A life test of this combination of thermo elements was made, together with others of nichrome-constantan and iron-constantan. These couples were made up in two series, one having only the original asbestos wrapping and the other being protected by kaolin mixture as above. Fig. 1 shows in graphical form the constancy

*To be published as part of a Technologic Paper of the Bureau of Standards.

¹The Constantan elements were obtained from the Driver-Harris Wire Company and the Electrical Alloy Company.

²From Driver-Harris Wire Company.

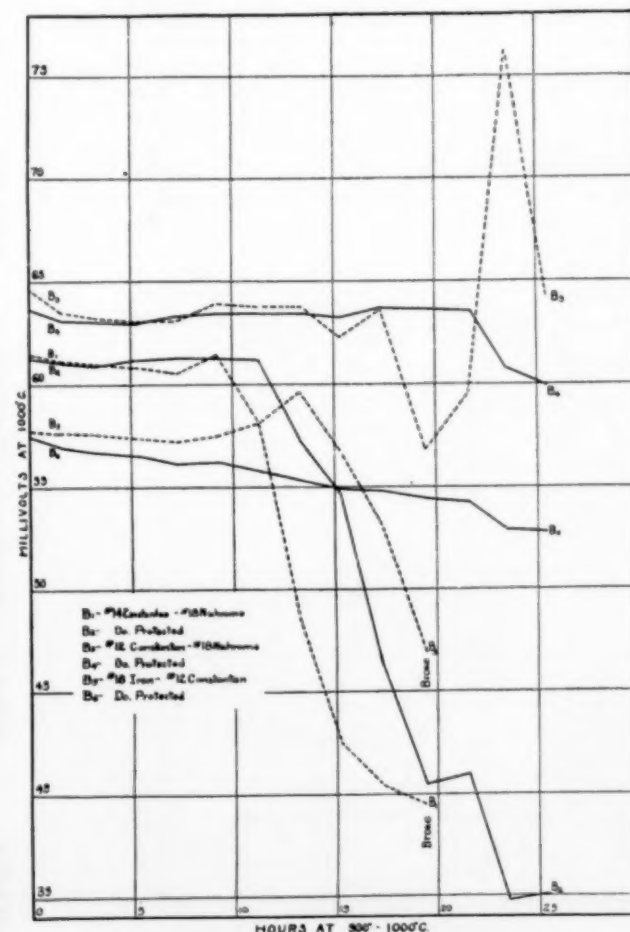


FIG. 1—LIFE TEST OF COUPLES

of these elements when kept for twenty-five hours at 1000 deg. C. in an atmosphere protected only from strong drafts of air. It will be noticed primarily that the protected couples not only have a longer life than those unprotected but that their calibration is more nearly uniform. The couples of nichrome-constantan maintain a very nearly constant calibration—to within 10 deg. C.—during their life, and can be relied upon to 10 deg. C. as long as there is a metallic electrical circuit, whereas the iron-constantan couple has a practically uniformly diminishing emf. The sharp breaks in the curves of Fig. 1 indicate the points at which the couples can be said to be beyond their useful life or to have failed. As would be expected the larger size of constantan wire gives the longer life in the combination nichrome-constantan. In all cases it was the constantan wire that failed, by oxidation and becoming so brittle that it readily broke; the nichrome wire never became brittle and showed no considerable oxidation.

Fig. 2 gives the calibration of the couple nichrome-constantan and the same data are given in Table I. This couple shows a remarkably high emf., the calibration curve is very nearly linear and shows no departure from a smooth curve. This same calibration was found to hold good to within 1 deg. up to 1000 deg. C. for other couples made of wire from the same lot, but it would probably be different for wires from other lots or other wires from this lot.

Couples were constructed of this combination for use in the investigation referred to and to date have been found to give very good service.

For use in air, therefore, to 1000 deg. C., even when only incompletely protected, this data and subsequent experience show that the thermocouple nichrome-con-

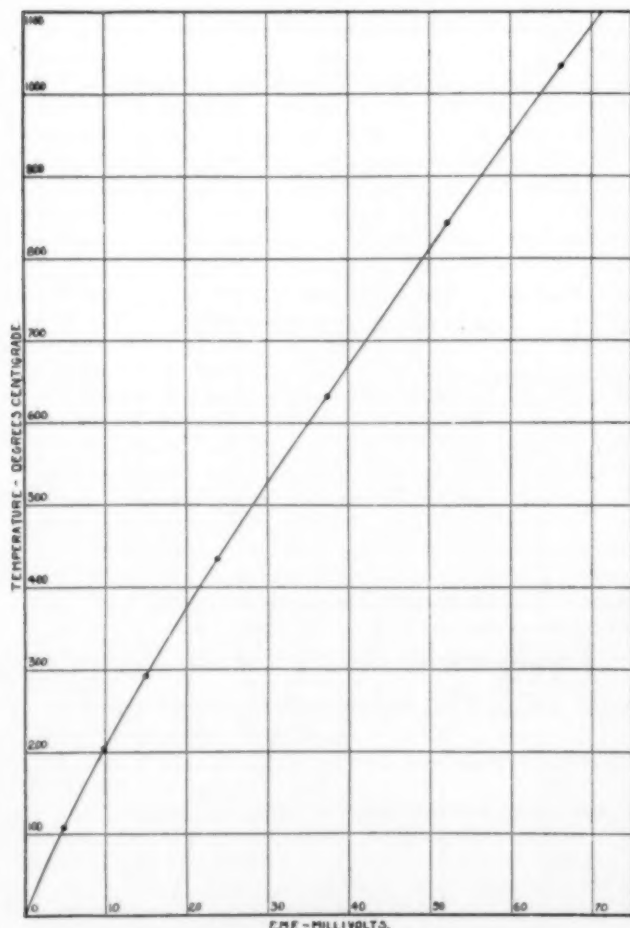


FIG. 2—CALIBRATION CURVE OF NICHROME-CONSTANTAN

TABLE I—CALIBRATION OF NICHROME-CONSTANTAN

Deg. C. Temperature,	Millivolts E. M. F.	Temperature, Deg. C.	E. M. F. Millivolts
108	4.92	632	37.4
204	9.90	842	52.2
292	14.9	1,033	66.3
434	23.8		

stantan will maintain its constancy to within 10 deg. C. (18 deg. Fahr.) until nearly completely oxidized. The emf. of this couple is high, 63.8 mv. at 1000 deg. C. as compared with iron-constantan, 57.5 mv. at 1000 deg. C.; nickel-constantan,³ 27.2 mv. at 1000 deg. C.; nickel-nichrome,⁴ 28 mv. at 1000 deg. C., and cobalt-constantan,⁵ 39.5 mv. at 1000 deg. C.

³C. Dannecker, *Ann. d. Phys.*, 42, p. 1504; 1913.

⁴E. F. Northrup, *Met. & Chem. Eng.*, 15, p. 197; 1916.

⁵O. L. Kowalke, *Trans. Am. Electrochem. Soc.*, 1916, p. 213.

Bureau of Standards,
Washington, D. C.

Some Theoretical Aspects of Electrical Fume Precipitation*

By W. W. Strong

The subject of electrical precipitation illustrates very well the relation between the technical development of a process and the state of our knowledge of the process itself. The practical application of the electrical precipitation of fumes was first made by Lodge and Walker about 1883. At that time absolutely nothing was known of the mechanism of the conduction of electricity in gases. The technical development of the subject was sufficiently far advanced to have made the application of it successful if the proper kind of high-voltage generating apparatus would have then been available. Lodge and Walker, however, had to depend upon an electrostatic machine for their source of corona current and, of course, could never obtain sufficient current to precipitate fumes from any considerable volume of gas.

About 1895 Dr. Cottrell¹ took up the application of electrical precipitation to the removal of certain sulphuric acid mist and smelter fumes from gases. At this time the theoretical development of the conduction of electricity from gases had been very considerably advanced. Dr. Cottrell, however, obtained his success through the fact that the technical development of high voltage generating apparatus had made it possible for him to use enormously larger currents than Lodge and Walker had been able to do. Since Cottrell started the above work, the technical advances in electrical apparatus used for producing high-voltage currents has been very rapid, and it is owing to this condition that the art of electrical precipitation is now becoming so widely applied.

The theoretical advances of our knowledge of the state of a gas or fume inside of the electrical precipitation treater has in the meantime advanced but little, though it is true that the phenomena of ionization in gases has been tremendously advanced in the past fifteen years. These advances, however, pertain more to the conduction of electricity in gases at low temperature, to the ionization produced by radio-active substances and the discharges taking place in arcs and sparks. In the process of electrical precipitation the ionization of the gases invariably takes place at atmospheric pressure and in a region of space in which the electric

*A paper presented in the Symposium on the Smelter Smoke and Fume Problem at the joint meeting of the New York Sections of the American Institute of Mining Engineers and the American Electrochemical Society on January 26, 1917. The other two papers presented in this symposium, by Ligon Johnson and Linn Bradley respectively, were published in our issues of Feb. 15, p. 199, and March 15, p. 336.

¹Cottrell, *Problems in Smoke, Fume and Dust Abatement*, Smithsonian Report, 1913.

field is very powerful. Unfortunately, very little has been done from the scientific point of view upon the phase of the conduction of electricity in gases. This subject will form a large part of this paper.

The theoretical aspects connected with the electrical precipitation problem can be roughly divided into two groups, those pertaining to the purely theoretical problems of the phenomena of the corona discharge in fumes and smoke and the subsidiary problems relating to the installation and operation of electrical precipitation apparatus. In the last group arise problems such as that of the generation of high-voltage uni-directional corona currents, the design of insulators that can support high voltages in gases containing fumes, mist and smoke, and subjected to considerable temperature fluctuations, the problem of the flow of gases through a treater containing a large number of pipes, the problem relating to the effect of various frequencies of the voltage of precipitation, and others of a similar nature. A number of these problems have been considered in Mr. Bradley's paper, and for this reason and others this group of problems, especially as they are more or less subsidiary in the art of electrical precipitation, will not be treated here.

THE PURELY THEORETICAL ASPECTS OF THE PRECIPITATION

The conduction of electricity in gases as regards their commercial application is of two types. In the one type the electrical current is partly or largely carried by electrons or ions that have come from the electrodes between which the gas is situated. As an example of this type of discharge, we might cite the electric arc. In this case the current is carried very largely by ions emitted by the electrodes and by the metallic vapor distilled from the electrodes, the gas itself not playing an important rôle in carrying the current. In the second type of electrical discharges in gases, the current is carried entirely or almost entirely by ions formed of the gas molecules. Examples of this type are those of the fixation of atmospheric nitrogen, the formation of ozone and the electrical precipitation of suspended matter from gases. In all these cases the effort is made to prevent the electrodes from playing any part in the conduction of the electricity except that of providing the electric field to which the gases are subjected. In the fixation of atmospheric nitrogen the electrodes are frequently cooled by water or by other means. In the formation of ozone and in electrical precipitation it is not found necessary to cool the electrodes.

In treating the phenomena of the electrical discharge in precipitation treaters, the simplest type of treater from the scientific point of view will be used, this consisting of a wire axially placed in a cylinder, the wire and cylinder being maintained at a high difference of electric potential. Under these conditions the gas about the wire is made luminous, this luminosity appearing as a halo or corona when the wire and pipe are viewed end on. The first application of apparatus in engineering work in which a discharge of this kind took place was that of high-voltage transmission lines. In these cases the discharge was always located about the immediate vicinity of the wire and was usually more or less uniform when viewed end on. Electrical engineers termed this "the corona discharge." In the case of electrical precipitation, however, the discharge takes place a much greater distance from the wire, and often presents a brush-like appearance, resembling the electrical discharge from points. For this reason the electrical discharges in precipitation treaters has often been spoken of as a "corona," a "point" or a "brush" discharge. The inconvenience of the use of these terms is immediately apparent and it seems best to always refer to the dis-

charge as the "corona discharge," even though the appearance of the luminosity is not uniform. The brush-like discharges in the corona may then be considered as constituting part of the corona discharge.

The electrical precipitation process from the theoretical point of view can be divided into (a) the formation of ions, (b) the charging of the fume particles by the ions, (c) the driving of the fume ions to the passive electrode, and (d) the collection of the fume at this electrode. If no ions were formed, if the ions could not be made to stick to the fume particles, or if the fume ions could not be driven to the collecting electrode by the electric field, electrical precipitation of fumes would be impossible. The ease of formation of ions depends upon the kind, temperature and pressure of the gas. Neglecting the effect of space charges, the formation of ions in a gas probably is not greatly affected by fumes and smoke, though it may be to some extent by the presence of vapors. The nature of the fume particles probably greatly affects the ease with which fume particles hold ions.

Some fume particles, composed of material such as zinc oxide, may cause a reflection of the ions that collide with them. Under these conditions a thin layer of some conducting substance over the surface may make it possible to charge the fumes. This does not mean that a vapor should be added to the fume and the temperature lowered below that of condensation, because films of impurities are known to adhere very tenaciously to solids. The persistency of impurities in adhering to surfaces of solids is shown by the filaments of electric lamps.

A word should be said as to the nature of ions. The smallest known ion is the electron, about 10^{-13} cm. in radius. Electrons may exist in the corona current in precipitation treaters, but most of the current is carried by what is called simple ions, *i.e.*, charged molecules or groups of charged molecules that carry a charge. The radius of such an ion is 10^{-7} to 10^{-8} cm. Charged fume, dust or smoke particles become charged by electrons or simple ions colliding and sticking to them, thus forming fume ions. The size of fume ions ranges from the larger ones that are visible down to dimensions of about 10^{-5} cm. radius. The term "fume ion" is thus defined, and varies with the kind and condition of the

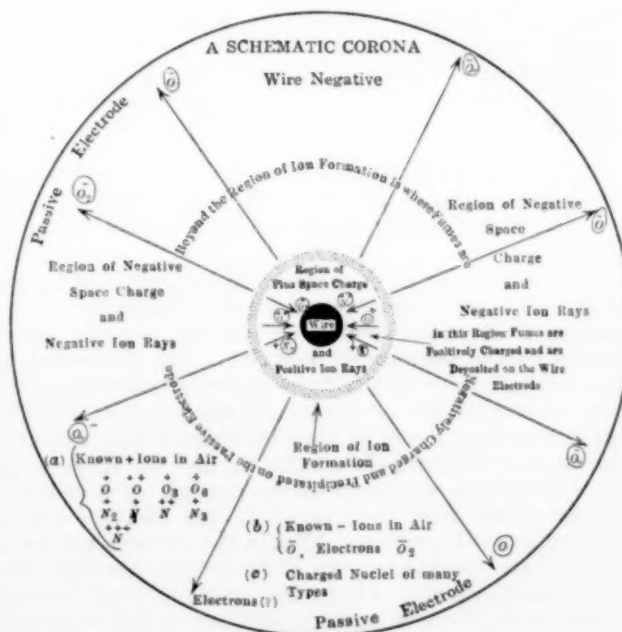


FIG. 1—A SCHEMATIC CORONA

fume, dust or smoke and the amount of electrical charge which it carries.

The nature of the space charges is shown in Fig. 1. In the region of the wire electrode is located the active electrode rays (consisting of positive ion rays if the wire is negative) and a space charged by these rays (region of active electrode space charge); the region of ion formation where ions are formed by the collision of ions with gas molecules and hence a region where the electric field gradient is very great, and which is also the region of the passive electrode rays where the space charge has the same sign as that of the active electrode. These regions of the corona, *a*, *b* and *c*, are characterized by different precipitating properties.

Fume or smoke particles that get into the region *a* are charged and attracted to the active electrode. Fume or smoke particles that get into *b* may be charged with either sign of charge, and may accordingly be driven to either electrode. Fume or smoke particles that get into the region *c* are charged so that they are precipitated upon the passive electrode. In the precipitation of fumes it is always best to prevent the fumes from entering the *a* and *b* regions, where they become precipitated upon the active electrode and cause trouble by interfering with the corona discharge.

The quantity of space charge in a pipe depends upon the nature of the ions and the electric potential impressed on the electrodes. These problems will be more fully considered in a later communication. The effect

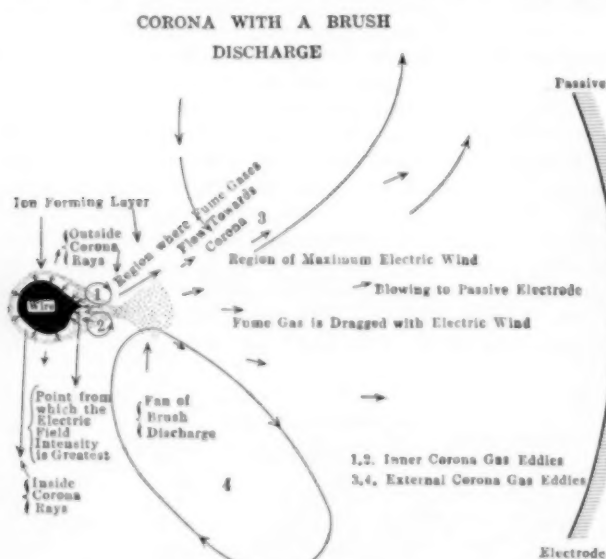


FIG. 2—CORONA WITH A BRUSH DISCHARGE

of space charges is to decrease the quantity of ionization and hence choke down the corona current.

Fig. 2 illustrates how a corona may become unbalanced by the presence of deposits on the electrodes, by a non-uniformity of the fume gases in the treater, and also by the nature of the corona discharge itself. The unbalancing of a corona from its symmetrical discharge about a wire electrode results in the discharge being localized in certain parts of the treater. The pressure of the fume gases is greatest in the localized corona regions, and this sets up eddies in the gases as indicated. Fumes are therefore more likely to pass through that portion of the pipe where the corona is least intense. In a treater consisting of a number of pipes there is always a possibility of the corona becoming localized in a few or even one of the pipes. This localization of

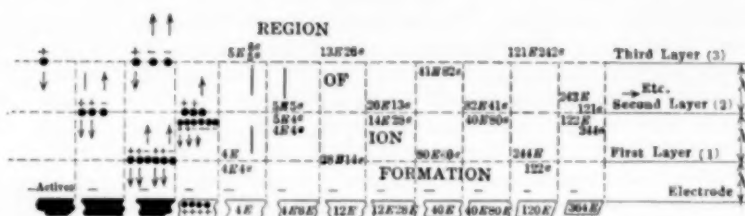


FIG. 3—ACTIVE ELECTRODE SECTIONS

corona may take place without the formation of sparks or arcs.

IONIZATION IN THE CORONA

Fig. 3 shows how a corona current starts and the nature of an ionization current in a gas.

(1) The corona is usually assumed to start from the natural ionization of the gas. The electric field may ionize a gas itself under certain conditions. Fig. 3 shows how ions are easily formed when there is a sufficiently intense electric field acting over a depth of three or more mean free paths. In the figure the mean free path of an ion and a molecule is assumed to be the same, and given the value in air at 76 cm. pressure and 0 deg. C. The length of time between collisions is thus $1/4,600,000,000$ second. If this period T is magnified to one second, the period of a 60-cycle current would correspond to about three years. It is thus seen that there is equilibrium between ionization and field as regards the starting of the corona, because the question of a few T times intervals can be neglected.

The natural ionization of a gas which accounts for the lag effects in point discharges would probably produce a lag effect in the corona discharge. So far no investigations have been made along this line.

(2) The condition of ionization equilibrium is determined by the state existing when the space charge due to the moving ions lowers the electric field so that the rate of formation becomes uniform. This condition should not be confused with the condition of chemical equilibrium, which is very important in the case of the corona discharge in air. Ozone, hydrogen, peroxide, oxides of nitrogen, and possibly other compounds modify the corona discharge, and hence the corona discharge may keep on changing while the quantities of these compounds are changing.

Time	0T	2T	3T	4T	5T	6T	7T	8T	9T	10T
Current flow to active electrode.....	0	0	0	4E	4E	12E	12E	40E	40E	120E
Through first layer.....	0	0	0	6	18	18	60	60	180	180
Through second layer.....	0	3	12	12	39	39	120	120	363	363
Through third layer.....	1	1	4	4	19	19	58	58	181	181
Space charge—										
Through first layer.....	1E	0	12	0	5e	0	13e	0	41e	0
Through second layer.....	0	1E	0	1e	0	1E	0	1E	0	1E
Through third layer.....	0	0	2E	0	4E	0	14E	0	40E	0

E represents a unit + charge.
e represents a unit - charge.

ITEMS

A space charge that is fluctuating.
A double layer.
The fluctuations of an electrical current in a gas.
An explanation of how a corona starts.
 $T = 1/4,600,000,000$ sec. $\frac{1}{4}$ cycle (i.e. time for e.m.f. to go from 0 to max.) = $1/240$ sec.
If $T = 1$ sec. $\frac{1}{4}$ cycle = $\frac{1}{4}$ year.

FIG. 3

(3) Fig. 3 shows how one ion starting at time $T = 0$, produces 2 ions at time $E = 1$, and the action of these ions results in 9 ions being in the gas at a time $T = 3$. In the present case we have neglected ion recombination and diffusion. The figure shows very clearly how at any time the current through various cross-sections of the gas varies, and how the current through the same cross-section varies with the time.

(4) Fig. 3 shows how the moving ions act as a space

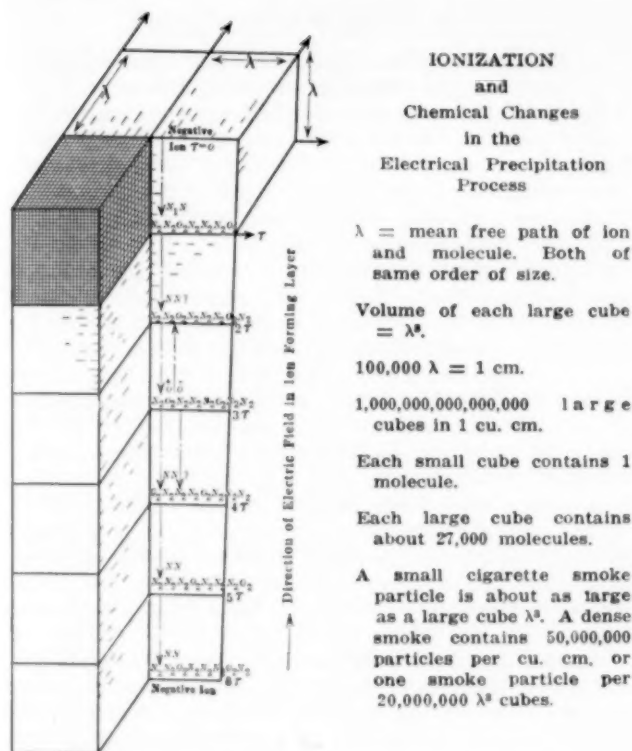


FIG. 4—IONIZATION AND CHEMICAL CHANGES

charge. In the case of the rapidly moving gas ions the space charge does not injure precipitation. It can be shown that the fume ions may be the source of a space charge that will choke back the corona current. The figure shows how the space charge fluctuates at any point.

Fig. 4 is made to illustrate the small part that fumes play in the corona discharge. A mean free path cube (λ cube) is one for which the length is that of the path of an ion between collisions and represents the size of a very small fume particle. Each of these cubes contains 27,000 molecules. In dense smoke there is not more than one smoke particle per 20,000,000 of these cubes. Possibly a better picture of the relative size of these particles is this:

An electron—a pin head.

A molecule—the Engineers' Building in New York City.

A mean free path cube—about thirty Pennsylvania railroad stations packed in a cube.

A small fume or smoke particle—Manhattan Island.

The question is frequently asked as to how theory aids in the application of the electrical method to precipitating fumes, dust, smoke, mists, fogs, etc., from gases, the idea prevailing that the operation is extremely simple. The latter view is entirely incorrect, and the illusion is usually dispelled when a treater is to be kept in continuous operation. In short the accurate knowledge of the phenomena involved in precipitation is useful (a) in improving the apparatus; (b) in making present operation more effective in every way; (c) in accurately comparing the various methods of removing suspended matter from gases, and (d) in opening new fields for technical operation. The possibilities of improvement in the process are very great and the next few years will see even greater advances than in the past. This can be the more readily admitted when it is remembered that the present technical plants have only been out of the laboratory for a few years.

In present operations of electrical precipitation the value of a thorough knowledge of the process is just as

necessary as in the running of an automobile, an aeroplane or any other piece of apparatus. A partial knowledge of a subject may be sufficient for most cases, but circumstances invariably arise that require technical and perhaps even theoretical skill. It is too easily forgotten, too, that the theoretical knowledge of to-day becomes the technical skill of to-morrow. A résumé of these problems will be made in a later communication. A full knowledge of the precipitation of suspended matter from gases is necessary for the proper comparison of the centrifuge, the settling, the washing, the electrical and other processes used for cleaning gases. The fixation of nitrogen, the formation of ozone, the disinfection of gases, the differential separation of different materials from gases and the conservation of the heat in gases, are among the many wider applications of the electrical process.

The theory of the corona discharge (with further experiments to make it apply to each type of smoke, dust, fume, mist or fog that constitutes a commercial problem) permits determination of—

(1) The exact calculation of the paths of the fume ions in a treater.

(2) The life of the fume ions and the time required to precipitate them.

(3) The evaluation of the precipitation constant.

(4) The effect of space charges.

(5) The amount of energy flowing into the treater that is actually expended in the precipitation of the fumes.

(6) The maximum velocity of the fumes for complete precipitation.

(7) The calculation of the best size and type of electrodes for a given type of fume.

(8) The best process to apply when it is found difficult to ionize fume particles.

(9) The smallest sized treater necessary to clean a given volume of fume in a given time.

(10) The separation of particles of a substance when a part of a mixture.

(11) The separation from each other of substances that possess different volatilities.

(12) The effecting of chemical reactions such as the fixation of nitrogen, the oxidation of various substances, etc.

(13) Probably the most important application is that of giving a perfect knowledge of the subject in place of a hit-and-miss, vague guessing and surmising state of knowledge that leads laymen to suspect the engineers connected with the work. This psychological effect has played a very important rôle in the past and will be important in the future.

Some of these items have been treated in previous papers, some in the present one, and a complete treatment of the whole subject is being prepared.

THE LIFE AND TRACKS OF FUME IONS

The fumes enter the precipitator pipe at a density of n particles per cu. cm. These particles become ionized to fume ions and are driven to the pipe by the electric field. The time thus required to precipitate a fume ion will be defined as the life of a fume ion and the path it traverses as the track of the fume ion. The longitudinal velocity of the fumes through the pipe does not affect the life of the fume ion excepting as they may cause a modification in its charge, but it changes the tracks of the fume ions very greatly.

Consider a pipe treater with a corona of radius r_c , pipe of radius R and a cylindrical shell of radius r and thickness dr within the treater. The fume particles become fume ions gradually, but for complete precipitation all the particles become ions. The fume particles

$2\pi nrdr$ in a unit length of shell eventually become fume ions, each traversing a distance $R - r$ to reach the pipe.

The total distance traversed by all the fume ions of this unit section before precipitation is,

$$\int_{r=R}^{r=r_c} 2\pi nrdr(R-r_c) \quad (1)$$

The number of fume particles is

$$\pi n(R^2 - r_c^2) \quad (2)$$

(1) divided by (2) gives the average length of track of the fume ion as projected on the r axis,

$$\frac{1/3R^3 - Rr_c^2 + 2/3r_c^3}{R^2 - r_c^2} \quad (3)$$

In precipitation work $R = 30r_c$ approximately, (3) becomes $0.3330R$.

The velocity v of a fume ion is the product of the electric field intensity by the mobility K ,

$$v_r = E_{vK} = k \frac{Ep}{r \log_2 \frac{R}{r_c}} \quad (6)$$

The fume ions will be carried longitudinally along the pipe by the fume gases with a velocity v_z in the y direction. One has the velocities

$$\frac{dr}{dt} = v_r, \frac{dy}{dt} = v_z \quad (7)$$

$$\int r dr = \int \frac{Ep k}{\log_2 \frac{R}{r_c}} dt, \int dy = \int v_z dt \quad (8)$$

In the simplest conditions where the constants of integration disappear,

$$1/2r^2 - 1/2r_c^2 = \frac{Ep k}{v_z \log_2 \frac{R}{r_c}} y. \quad (9)$$

This is the general equation giving the track of the fume ion in a gas.

Let V be the potential difference applied across the electrodes, E_r the potential gradient at any point r cm. from the center, E_c the voltage drop between the corona and wire and E_p the remainder of the voltage drop, the driving potential precipitating fume ions to the pipe.

$$E_p + E_c = V \quad (4)$$

The potential gradient at any point neglecting space charges would be (where a is the radius of the wire),

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The effect of space charges upon the value of the potential gradient will be treated in a later paper. It seems quite certain that any choking of the corona current by space charges is due to ions possessing a mobility of less than 0.1 cm. per second.

$$P = \frac{Ep k}{v_c \log_2 \frac{R}{r_c}} \quad (10)$$

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Grading of Graphite, Gunpowder and Malt

By Edward S. Wiard

Graphite

The mining of graphite is a very hazardous business undertaking and one accompanied with slight success even where conditions are most favorable. Graphite is of four kinds, the amorphous graphite of Mexico, artificial graphite, flake graphite, and fibrous graphite, the bulk of which comes from Ceylon. Graphite as mined in the United States was confined until recently to the Adirondacks region of New York State. Here the deposits are in schists through which the graphite is disseminated and the separation from the accompanying minerals, particularly mica, is very difficult. The Joseph Dixon Crucible Company, owing to its manufacture of the dressed graphite into various products, is, practically speaking, the only company mining in the region which has had stability. Some of the causes contributing to the decline of the graphite industry in the United States are: the superiority of other forms of graphite and the greater cheapness with which these are mined, and, in the case of the Ceylon graphite, its delivery to the market in a refined condition. Recently, however, there has been marked activity in graphite mining in Texas.

The use of flake graphite is practically confined to the manufacture of lubricants and foundry facings. Ceylon graphite is exclusively used for making crucibles and to a minor degree in the manufacture of lead pencils. Much of it also goes into foundry facings and stove polish. Ceylon graphite can be laid down in the lump or best grade at Eastern factories for about 9¼ cents per lb. in barrels holding about 600 lb. There is about 92 per cent pure carbon in this grade. The best grade of finished American flake does not bring over 7½ cents a lb. In 1913 the imports of Ceylon graphite to the United States amounted to 8374 tons, valued at \$920,147. The domestic production amounted to 4336 tons, worth \$324,118 in the same year. The United States takes about a third of the Ceylon output.

In the Ceylon deposits the graphite occurs as veins in gneissic rocks and in crystalline limestones which are interbedded with these rocks. The veins consist of pure fibrous graphite and are from a few inches to several feet wide. Following mining in open pits or very shallow underground openings, the mineral is screened, then cleaned by cobbing and sorting. Following these operations various kinds are blended to suit the requirements of purchasers. The poorer material remaining from the sorting and cobbing operations is ground to a powder by hand beaters and then graded.

In the Adirondacks there is no well defined system of milling; the flowsheets of the mills vary widely and often employ separating machines which are only partially successful or which are in the experimental stage. In some mills the procedure may be generalized as follows: The ore is crushed to about 5 mesh and then submitted to a flotation process to remove the fines. What does not float is then dried, graded and air jigged. The cleaned product resulting from the jigging is ground in buhr mills and bolted in gyratory bolters.

The points which make graphite valuable as a crucible material are that it does not fuse below temperatures at which most metals and alloys melt. Less fuel is required to make a melt owing to the good conductivity of the graphite. Graphite crucibles stand sudden changes in temperature well. A flaky product is required and the least of this used the greater the amount of refractory material which must be added to hold the mass together, thus enhancing the value of the crucible.

The graphite is ground in buhr mills, the number of

grooves cut in the stones being fewer than when such stones are used for other purposes, the idea being to flatten the fibrous graphite rather than to grind it. From the mills the graphite is elevated to gyratory bolters, the coarsest screen used not exceeding a 12 mesh. The oversize from this screen is returned to the grinding mills. The next size screen may be a 16 mesh and the third a XX silk cloth. The first two screens are brass cloth. The undersize of the XX is used as foundry facing and stove polish. The gradings from the bolter are mixed with the proper proportion of sand, kaolin and water and carefully weighed balls of the mixture are introduced into revolving plaster molds.

While the mold is revolving with its contents a curved blade of the contour of the interior of the crucible is lowered a number of times to force the mass up against the mold, coating the interior of the crucible to the desired thicknesses and producing a skin which completely lines the crucible. The lip of the crucible is put on by a few deft movements of an attendant, a portion of the mold being removed for this purpose. The mold and contents are allowed to dry for about seven hours when the green crucible is removed to a rack to finish the drying. In the kilns the crucible is at a red heat for one week.

Foundry facings and material for stove polish are also made by grinding inferior grades of Ceylon graphite in buhr mills, followed by screening. Ordinary and centrifugal silk reels are employed for grading the ground graphite. As many as seven sizes of cloths are attached to the reels. Flake graphite for lubricants is prepared at the mine mill, the compounding of the lubricant being done at the factory.

In the manufacture of lead pencils the principal ingredient is amorphous graphite which comes mainly from the Santa Maria graphite mines of Sonora, Mexico, situated about 20 miles south and a little east of La Colorado in central Sonora. These are the largest amorphous graphite mines in the world and the quality of the product is typical. The graphite occurs in sandstone which has been intruded by granite; the graphite being the result of the metamorphism of coal beds by the igneous rocks. In other parts of the same region all grades of coal are found from soft to anthracite.

The product mined is sufficiently pure to ship directly to the plant of the United States Graphite Company, who own the mines, and where the refining process consists in grinding in tube mills. From these machines the product passes into Raymond air separators. The tube mills are run in closed circuit, the coarse material dropping back into the tube mills. The finished product is impalpably fine. Large amounts of the Mexican graphite are exported for pencil making, it being equal to the Bohemian and Bavarian graphite for this purpose.

The best pencils are a careful blend of amorphous graphite and Ceylon graphite. The Ceylon graphite adds to the smoothness of the lead, the amorphous adds unctuousness and flowing quality, which can be obtained with no other form of graphite. In making pencils the graphite is mixed with carefully refined clay. The greater the proportion of graphite the softer the pencil and the more the proportion of clay the harder the resulting pencil lead. Following the thorough mixing the ingredients are forced into molds and when the green leads are sufficiently dried they are baked.

In the manufacture of artificial graphite, anthracite coal or oil coke is charged into electrical furnaces and subjected to the highest possible temperature. The material fed to the furnace is crushed to at least one-half inch by corrugated rolls. After the mass has been removed from the furnaces and cooled it is broken up and passed into tube mills and from these machines it goes to air separators, the regulation of the blast giving

as fine or as coarse a product as is desired within certain limits. The capacity of the separators varies from 600 to 1000 lb. per hour. The grades made are determined by the proportion which will pass a 200 mesh screen, the range being from 75 to 99 per cent. There is also a grading according to the purity of the graphite. The finest and best grade of the artificial graphite is used for clamp paste for incandescent lamps. Other grades are used for lubricants, paint, electrodes and electrotypers use. The suspended forms in oil and water for use as lubricants are of great interest and value. Artificial graphite is not used for pencil making as it is lacking in an unctuous quality.

Gunpowder

Most black powders, outside of cannon powder, are graded so as to regulate the burning effect. The finer the powder the faster the burning. As the powder becomes successively comminuted, however, the increase in the length of the interstitial passages lowers the rate of burning, since, owing to increased friction, the heated gases cannot pass so rapidly to the interior of the charge. The laws of some states require that black blasting powder shall be rigidly graded into a prescribed number of sizes.

The principal use of black powder is for blasting in coal mining. Thus in Illinois the black blasting powder must have a range of specific gravity between 1.74 and 1.90 and when leaving the factory have a moisture content not to exceed 1 per cent. Seven sizes are prescribed, CCC a powder which will pass a screen having round holes, 40/64-in. in diameter, and remain on a screen with holes 32/64-in. in diameter. CC powder, which will pass a screen having round hole perforations 30/64-in. in diameter and remain on a screen having perforations 24/64-in. in diameter, etc. The smallest size FFFF, is one which will pass a screen with 5/64-in. openings and refuse a screen with 2/64-in. openings.

In the manufacture of a nitrate or chlorate powder the oxidizing agent is mixed with sulphur and carbon in a form of Chilean mill, a little water being mixed with the charge is ground for four or five hours. Great care has to be exercised that the powder does not flash by the rollers coming in contact with the pan. After the powder is thoroughly incorporated it is passed through rollers and is then made into sheets by a hydraulic press. Following this operation it is granulated by passing through toothed rollers with varying sets. It is then screened on flat brass screens, then dusted in revolving screens and glazed with graphite, about $\frac{1}{2}$ oz. being used to the 100 lb. of powder. After thorough drying the grains are again dusted.

The evenness of burning of powder depends upon thorough incorporation of the ingredients, invariably of composition, careful and close grading and uniformity of the shape of the grains.

Malt

Malt is converted barley. The barley is cleaned by methods which are similar to those described under wheat. In malting the barley is first steeped in water from 24 to 40 hours, which causes the grain to take up from 10 to 30 per cent water when it swells and begins to germinate. Following this operation the grain is piled up and the heat created by vital actions conserved, the growth thus being stimulated. The grain is then stirred to check the growth of the rootlets and to stimulate the growth of the acrospires. Finally the grain is dried, the germination being completely checked. A malt kiln is used for this purpose. The grain is then screened when the rootlets and acrospires fall off.

The chemical changes effected are the conversion of azotized substance into diatase, the conversion of starch into grape sugar and the imparting of color and flavor to the malt. The malt is either light colored or dark according to the amount of heat used in the kiln. When heating is prolonged more empyreumatic oil accumulates in the grain and it has a sharper, stronger flavor.

The principal advantage which would result from grading barley would be that with uniform-size berries, the germination period would be about the same for all the individuals and the various steps in the malting process would be better defined and easier regulated.

The Rich grader has been proposed for this service. (U. S. Patent 410377, Sept. 3, 1889 and later ones.) It consists of batteries of disc rings held together by rods and nuts and spaced by washers. The rings are kept free by a brush device. It is said that all grain is of about the same length and varies in dimension only in thickness. The Rich grader allows the grains to pass through the openings in a direction parallel to the short axis, a condition impossible to obtain with any other screening device. Even if the grains were of the same thickness in all directions the close sizing required could not be effected by screens.

The McKesson machine principle could also be employed for the same purpose, or for grading coffee and beans, uses for which the Rich grader has been proposed.

Specific Gravity in Rubber Compounding

By Andrew H. King

The first thing the young compounder learns is an appreciation of specific gravity. As is well known, this term is simply the ratio of the weight of a given volume of the substance to that of an equal volume of water. In the metric system the word "density" is substituted, and the term becomes mass per unit volume; in other words, grams per cubic centimeter. Density is so intimately bound up with cost that the term volume cost, i.e., price per pound times the specific gravity, is generally used as a basis of comparison for the various stocks. The justice of this scheme becomes apparent when one considers the importance of volume. Only in a few lines is the manufactured article sold by weight. The consumer is not long in discovering the shortage when packing of 2.10 sp. gr. is substituted for that of 1.40 sp. gr. The question then is, with most stocks, how far will 100 lb. of it go? This known, the price per pound is then to be considered. For the sake of clearness, let me say that the above applies to the great number of stocks in daily use in the rubber factories, and not to that small portion which yield a porous product, as for example, sponge stocks. In this case it is apparent specific gravity which counts.

The specific gravity of a stock may be determined by a number of methods. These may be outlined as follows:

1. *Balance.*—This method depends upon the law of Archimedes, which states that a body immersed in a liquid loses a weight equal to the weight of the displaced liquid. The piece of rubber is suspended on the left arm of a balance by a silk thread and weighed. It is then immersed in water and thoroughly wetted; all air bubbles are carefully removed. This may be facilitated by first immersing the sample in alcohol. Subtracting the weight in water from the weight in air gives the loss of weight in water, which represents the volume. Consequently the specific gravity is obtained by dividing the weight in air by the loss of weight in water. Some operators make allowance for the weight of the thread or string, but for ordinary work this is unnecessary.

2. *Jolly Balance.*—Here instead of the weights of the

chemical balance we have a coiled spring. One pan is so arranged as to be always in air, and the other one always in water. Observations are made by reading the position of the image of some object attached to the base of the spring in the mirrored scale placed behind. It is well to read the zero position both at the beginning and at the end of the operation. The sample is first placed in the upper pan and the reading taken. It is next wetted and placed in the lower pan. The zero reading is subtracted from these two, which now becomes analogous to the weight in air and the weight in water. The calculation is the same as above.

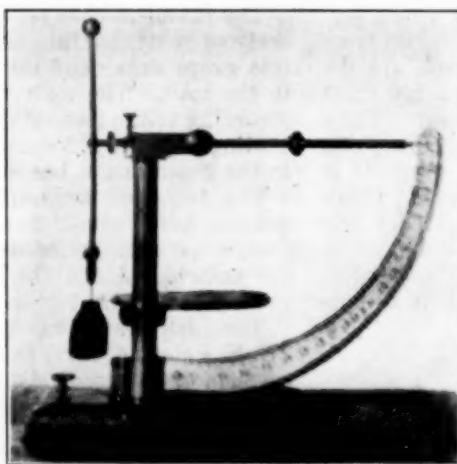


FIG. 1—FIRST POSITION OF GRAVITOMETER



FIG. 2—SECOND POSITION OF GRAVITOMETER

3. *Young's Gravitometer*.—This instrument (Figs. 1 and 2) has been placed on the market within the past year or so, and when in the hands of a skillful operator gives satisfactory service. The operation is simple. The sample is suspended on the hook, and the nut turned until the arm is balanced. In this position it is parallel with the plane of the table (Fig. 1). After wetting the sample first with alcohol it is immersed in water and the containing vessel raised up until the arm comes to rest (Fig. 2). The specific gravity is read off direct from the scale. From 1.00 to 2.5 the scale is fairly accurate, but beyond this the divisions are too close together. It is true, however, that fully 75 per cent of the stocks in daily use do not have a specific gravity in excess of 2.5. The idea is good, and it is hoped that it will be refined and made more sensitive. It is not suitable for determining the gravity of fillers.

4. *Picnometer*.—The ordinary specific gravity bottle used in determining the density of liquids is of great value when porous stocks must be examined. The sample is best cut into small pieces, placed in the bottle, and weighed. Fill the bottle about half with distilled water and gently boil for a few minutes in an oven. Let cool and attach to an ordinary water suction pump. Let run for an hour or more. In this way all the contained air will be removed. Calculations are as follows:

Weight of bottle when full of water	= a grams
Weight of bottle	= b
Weight of water contained	= a - b
Weight of bottle + sample	= c
Weight of bottle	= b
Weight of sample	= c - b
Weight of bottle + sample + water	= d
Weight of bottle	= b
Weight of sample + water	= d - b
Weight of sample	= c - b
∴ Weight of water contained in presence of sample	= d - c
Weight of water when full	= a - b
Weight of water displaced by sample	= (a - b) - (d - c)
∴ Volume of sample	= a - b - d + c
The specific gravity or density (grams per c.c.) is then	= $\frac{c - b}{a - b - d + c}$

The method is equally satisfactory for pigments.

The theoretical gravity of a stock can be easily calculated from the gravities of the various compounding ingredients. The values given below are not to be taken as absolute, since all fillers are more or less impure and will therefore vary in gravity. These figures have been found to be satisfactory in the great majority of cases.

Most compounders make their batches add up to 100

Filler	Sp. Gr.
Antimony sulfide	3.20
Arsenic, yellow	2.75
Asbestine	2.60
Aluminium bronze	3.20
Aluminium flake	2.65
Barytes	4.35
Blue, ultramarine	2.40
Black, bone	2.20
Black, lamp (gas)	1.73
China clay	2.40
Calcium sulfate, gypsum	2.30
Glass, powdered	2.49
Graphite	2.18
Hydrolene	1.00
Litharge	9.25
Lead, white	6.10
Lead, sublimed white	6.20
Lead, red	8.35
Lead, chromate	5.80
Lime	2.75
Lithophone	3.95
Magnesia, Oxide, Usta	3.45
Magnesium carbonate	3.00
Paraffine	0.95
Plumbago	1.95
Pumice	2.23
Red oxide, iron oxide	4.70
Rosin	1.05
Rubber (all varieties)	0.95
Sulfur	2.07
Substitutes (all varieties)	1.00
Tar	1.10
Talc	2.70
Tripoli	1.85
Vaseline	0.90
Vermillion	8.10
Whiting	2.68
Zinc oxide	5.60
Zinc chromate (yellow)	3.49

lb. This is a great help in figuring costs and in preliminary calculations. The following is an example of the method of calculating a theoretical gravity:

Ingredients	Per Cent Composition Grams to 100 of Stock	Density in Grams per c.c.	Each Ingredient per c.c.
Rubber	45	0.95	47.37
Sulfur	3	2.07	1.45
Lime	2	2.75	0.73
Zinc oxide	25	5.60	4.46
Red oxide	10	4.70	2.13
Barytes	5	4.35	1.15
Tripoli	10	1.95	5.13
	100		62.42

Therefore 100 grams of the stock is contained in $\frac{100}{62.42}$ c.c., or the specific gravity is 1.60.

It frequently happens that a compounder is required to furnish a stock of certain gravity besides conforming to other specifications. In such a case he will decide how much rubber is necessary, then from the period of vulcanization desired he can aim at how much sulfur and how much accelerator is necessary. He will next prepare a chart as above, and juggle his fillers until the right volume per 100 grams stock is obtained.

Synopsis of Recent Metallurgical and Chemical Literature

Benzene and Toluene from Cracking Petroleum Oils.

—In the *Oil, Paint and Drug Reporter* of May 7, 1917, ANDREW BENDER claims that the Rittman process has turned out a failure in commercial practice. Concerning the Aetna Explosives Company's Rittman installation which was abandoned a year ago, he says that during the last six months the plant was operating an average of 8,500 gallons per day of oil were put through the furnaces. Analysis of the cracked oil showed an average 3 per cent of benzene and $2\frac{1}{2}$ per cent of toluene on the basis of the oil used. Only about half of this small amount of benzene and toluene could be removed from the oil on subsequent refining, and neither of these hydrocarbons could at any time be obtained sufficiently pure to be profitably used. The heavy oil containing much carbon as it came from the furnaces was, after settling, distilled in fire-heated stills, and the distillation was stopped when the vapor reached 177 deg. C. The residue was put through the furnaces again. The distillate, called "Rittman distillate," was next "refined." This distillate contained a relatively large amount of sulphur dioxide. Corrosion of the refining stills made it necessary to next distill this oil in simple non-fractionating stills, passing the vapors through caustic liquors to remove the sulphur dioxide. The distillate, freed from SO_2 , was next distilled in fractionating stills. Fractions which correspond in light oil refining to "Heads," "Crude Benzol," "Intermediates," "Crude Toluol" and "Residue," were made. The crude benzol and crude toluol fractions were washed with 66-deg. sulphuric acid in the usual way, to remove unsaturated hydrocarbons, which were present in unusually large amounts. The use of the necessary large amount of sulphuric acid caused excessive heating, which made this step of the process difficult and expensive. After washing with caustic soda, and finally with water, the benzol and toluol fractions were next rectified by further distillation. Unfortunately, these oils contained many paraffin hydrocarbons of approximately the same boiling points as benzene and toluene, and after repeated redistillations at one-half to one-fourth the usual rate of distillation, benzene and toluene of only 89 to 93 per cent purity could be obtained.

The best benzol obtained, and averaging 91 per cent pure, was used in part for denaturing alcohol where a refined benzol is not required. Some was used direct for the production of phenol, the 9 per cent of paraffins present being removed after the benzol was sulphonated. Some of the benzol was blended with three to four volumes of pure benzol obtained from light oil, and after blending was used as pure benzol.

The disposition of the toluene was not so easy. Of course, the toluene was intended for the manufacture of trinitrotoluene (T. N. T.). In the nitration of toluene containing paraffins, the paraffins present are in part polymerized and in part oxidized, but the resultant polymerization and oxidation products remain dissolved in the T. N. T., which necessitates recrystallization of the product. Indeed, direct nitration of the so-called "Rittman toluene" proved so hazardous that resort was made to blending the toluene with pure toluene from other sources. The T. N. T. thus obtained was so contaminated that blending had to be abandoned because otherwise passable T. N. T. was thereby rendered so impure that the entire lot had to be subjected to expensive recrystallization. Another method used for eliminating paraffins consisted in dissolving the mononitro-toluene first produced in 66-deg. sulphuric acid. After solution in the acid a large part of the paraffins

present separated as a layer on the sulphuric acid solution of mononitro-toluene. Much of the paraffins, however, even in the mononitration stage, were polymerized and seriously injured the product. Purification of the mononitro-toluene by distillation, as recommended by Dr. Rittman in his published description of the method, was never attempted on a large scale because of the danger attending this operation when such an impure nitrotoluene is distilled.

Over a long period of time the cost of producing benzene and toluene by this process was far in excess of the prices ever reached during the unparalleled period of high prices in 1915. The writer insists that soft coal is the most economical source of supply of benzene and toluene.

Corrosion

Corrosion of Tinned Sheet Copper.—The results of an investigation on the structure of tin coatings on copper are given in Technologic Paper No. 90 of the Bureau of Standards. The author is PAUL D. MERICA. The paper includes some interesting microphotographs. The attention of the author had been directed to a curious case of local corrosion or pitting in tinned sheet copper roofing. The pits occur in general along the line of surface scratches, having appeared some eight or ten years after completion of the roof. These pits are apparently unrelated to the service conditions and to the direction of rolling of the sheet. When the copper becomes exposed, as in the present case at the bottom of the scratches on the surface, it forms together with the alloy layer a galvanic couple, electrolytic action sets in, and the copper at these points is corroded, forming the pits described. This publication gives the results of a study on the structure of tin coatings on copper and it is shown that this coating consists of at least three layers, viz., a thin layer of Cu, Sn immediately next to the copper, then a layer of Heycock and Neville's constituent H, containing about 60 per cent by weight of tin, and finally a layer of the eutectic of tin and copper, in which is found most probably also the lead when it is present in the tinning mixture. Etching experiments and measurements of the electrolytic e.m.f. have indicated that these intermediate layers are electronegative to both the outer tin (eutectic) and the underlying copper itself (by from 5 to 50 millivolts), and less readily attacked by water and dilute acids (also alkalis). This is true also of tin coatings, containing lead, and holds not only for the corroded sheet examined, No. 1054, from the roof of the Library of Congress, but for all others examined, including several direct from the manufacturers. The results explain the local character and type of corrosion exhibited by the sample 1054. The coating is very thin and also quite variable in thickness and structure. The surface scratches have exposed the copper at various points. This exposure of the copper along these scratches is aided by the fact that the adjacent alloy layer is extremely brittle and readily torn or crumbled out. As long as the tin eutectic layer was present it has, owing to its greater corrodibility and electropotential, been first attacked, thus protecting the copper. Finally, however, after several years this layer has been almost wholly removed, and at those points where the copper is exposed the attack has set in, the copper, forming with the adjacent electronegative alloy layer a galvanic couple, of which the copper is attacked and eaten away, forming the pits as described above. The same thing happens at the points where, as has been shown, there is a break in the continuity of the alloy layer. Here the eutectic layer is corroded off, exposing the copper at once, the latter being corroded in similar manner as above described. It would thus appear that whenever the outer tin or eutectic layer of a tin coating

on copper is removed the alloy layer remaining gives only a mechanical protection from corrosion—that is, it does not protect the underlying copper electrochemically, as does zinc, iron in galvanized products. Corrosion of the type described, therefore, should be possible in any tinned copper material. Yet instances are known of tinned copper roofs, which have stood up for 20 to 25 years under apparently more severe service conditions without showing sign of any such pitting as has been described. For the variation in resistance to corrosion of different samples of this material many factors might be responsible. First and foremost is the question of the mechanical abuses received, such as scratching and indenting. This has been shown to be the determining factor in the case described. A sample of the roof from the Statehouse in Texas showed absolutely no scratches; this roof has resisted corrosion for twenty or more years. The other principal factor is undoubtedly that of the thickness and uniformity in structure of the coating. This varied quite noticeably in the various samples examined. The corroded sample, 1054, showed perhaps the greatest degree of nonuniformity in this respect. A third factor which must not be lost sight of in this connection is that of the electrolytic solution potential of the base copper itself. Experiments have shown that this may vary for different samples within several millivolts, a range which is of the same order of magnitude as that of the difference in electromotive force between the copper and the tin-copper alloy.

Chemistry and the War in Germany

Solving of Wartime Problems in Germany.—In the *Journal of the Society of Chemical Industry*, March 31, 1917, is given a review of some of the problems encountered by Germany since the war started, and how they have been solved. The information was obtained from the German technical journals. Most of the national wants have been foreseen long before they occurred, and whenever it has been possible the chemist has found a substitute, although not always an efficient one. Early in 1914, Germany foresaw that the struggle upon which she had then determined would be essentially a petrol war, and that every gallon of petrol would be required by her fighting services, and so the outbreak of the war found all the motor vehicles in Berlin, down to the taxicabs, provided with engines adapted to consume either petrol or alcohol. As some difficulties were experienced in using alcohol by itself, systematic experiments were made with mixtures of alcohol with benzene and other hydrocarbons, and the formulæ giving the best results were published in the chemical journals.

The first plant for the fixation of nitrogen from the air was established in Germany not many months before the war, and at the present time the bulk of the nitrates required for the manufacture of her explosives is derived from that source. Nor is this the only direction in which nitrogen obtained from the air has been utilized. With the increasing strictness of the British blockade it became essential to discover a substitute for nitrogenous feeding-stuffs for horses and cattle, about 500,000 tons of which had been imported prior to the war. To meet this deficiency it was suggested to the authorities that a special yeast, which had a vigorous growth, but produced no alcohol, should be cultivated and pressed on a large scale. This work has been carried out under the direction of the Institute of Brewing in Berlin. Enormous shallow tanks, like swimming baths, have been erected, and in the bottom of these are fitted pipes to maintain the optimum temperature for the growth of the yeast, which is cultivated in a medium prepared from refuse material from the sugar works

mixed with suitable salts, including ammonium salts obtained synthetically from the air. The compressed yeast is stated to be suitable not only as a nitrogenous fodder, but also for human food. It is estimated that before long Germany will be in a position to obtain from this source the whole of the nitrogenous fodder she requires, and that she will never again be dependent upon the outside world for her supplies.

In connection with feeding-stuffs it is significant that attention should at once have been directed to the utilization of kitchen refuse. Within two months after the outbreak of the war a notice was issued by Prussian municipalities that all householders were required to sort their kitchen refuse. All fatty material was to be kept separate, while the vegetable material was to be saved for fodder. As subsequently organized, more especially in the larger towns, it was prescribed that the fatty material should be taken to specified soap works, where the glycerin was to be separated and the soap returned to the householder. No one is allowed to make any soap privately.

One difficulty in dealing with the vegetable matter was the necessity of drying it quickly to prevent putrefaction, and it was suggested that the waste heat of the gas works should be utilized in this way, although subsequent issues of the journal do not state whether this has been done. Still more recently attention has been directed to the annual loss of potatoes by disease, and it is suggested that frost-bitten or diseased potatoes should be dried and used as an ingredient of fodder, or that they should be used in the preparation of starch. While Germany has been making use of kitchen refuse in this way for over two years it is only within the last month that any proposal to prevent this loss in England has been put forward.

The lack of oils and fats has been Germany's greatest difficulty and she has only been able to supply her wants of nitroglycerin at the expense of the health of the community. Hence the chemical papers have constantly published the results of the analyses of little-known home-grown seeds, which have never before been regarded as possible sources of oil. It has been shown that asparagus and other vegetable seeds contain a considerable proportion of oil, though it is doubtful whether they would repay the labor of extracting it. In two cases, however, the suggestion of the chemist has borne fruit. Horse-chestnuts are now systematically collected both for the separation of the large amount of oil which they contain, and for the preparation of a saponin extract to take the place of soap; while in Southern Germany the National Women's Guild has made itself responsible for the collection of the enormous quantities of cherry stones, which were previously thrown away. These are crushed and the kernels separated by an ingenious method of treatment with a solution of a salt of such specific gravity that the kernels float on the surface while the shells sink. The kernels are then dried and the oil expressed in the usual way. By means such as these Germany has made great additions to her supplies of oils, but the deficiency is too great to be materially alleviated by any device short of the synthesis of fat.

Mention might also be made of the various detailed experiments which have been carried out to discover palatable substitutes for tea, coffee, and cocoa, and of those upon which the composition of the so-called war-bread has been based. In every direction the German places himself in the hands of the expert chemist, and it is only the lack of raw material in certain essential particulars, which has prevented the chemist from solving every material difficulty with which Germany is now face to face.

Recent Metallurgical and Chemical Patents

Electric Furnaces

Electric Calcining Furnace.—A continuous electric furnace for heating coal, petroleum-coke, etc., to high temperatures for use in the manufacture of carbon articles, is patented by WILLIAM R. CLYMER of Lakewood, Ohio. The patent is assigned to the National Carbon Company of Cleveland, Ohio. A cross-section of the furnace is shown in Fig. 1. It is composed of three main parts; a water-cooled conveyor 1, an electric furnace, and a preheating chamber 3. In starting the furnace for continuous operation, material such as petroleum-coke is first fed into the hopper 60, until the preheater and electric furnace are filled to the extent indicated in Fig. 1. At this height no more material

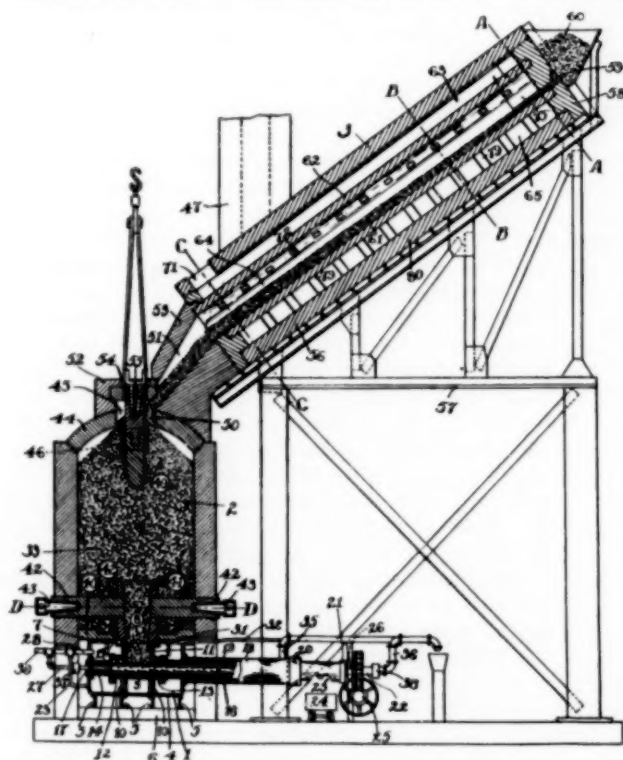


FIG. 1—CROSS-SECTION OF CALCINING FURNACE

will be removed from the hopper until some of the charge is removed at the base of the furnace. The heating is then commenced by blowing in a mixture of air and oil or gas, and burning the mixture until the charge in the preheater has been heated to a certain extent. When combustion has been started in this manner the conveyor screw will be rotated to cause a continuous passage of material through the entire apparatus. Since the original charge has not been properly heated, it will again be fed into the furnace or otherwise disposed of. As soon as the preheated charge reaches the electric heating region the electric current is turned on and the material is heated up to the desired temperature. The material is delivered to the electrical part of the furnace at a temperature of 1000 to 1200 deg. C. For this reason much less current is needed than in types of electric furnaces where the material is heated from room temperature to 2000 deg. C. The gases from the coke itself are utilized to preheat the material. The output of the furnace described is 1000 to 2000 lb. per hour (1,223,475, April 24, 1917).

Electric Furnace Electrode.—A carbon electrode with a coating of a mixture of fire-clay and graphite is patented by JESSE C. KING of Montreal, Canada. The

coating, which for ordinary purposes consists of fifty parts graphite and fifty parts clay by weight, is placed on the carbon electrode while the same is in the plastic condition. The whole is then baked to drive off the moisture and harden the electrode and its coating. The purpose of coating the electrode is to make it impervious to oxidation by gases, which would shorten its life (1,223,986, April 24, 1917).

Blast Furnace with Auxiliary Electric Heating.—A blast furnace for iron or other metals, having bottom and top electrodes in addition to the regular equipment, is patented by HENRY M. CHANCE of Philadelphia, Pa. A cross-section of the furnace is shown in Fig. 2 in which 1 indicates the shaft wall of the furnace, equipped with charging bell 2, 3 indicates the bosh of the furnace, 4 the blast tuyers, 5 the crucible of the furnace provided with a slag tap 6 and metal tap 7. One or

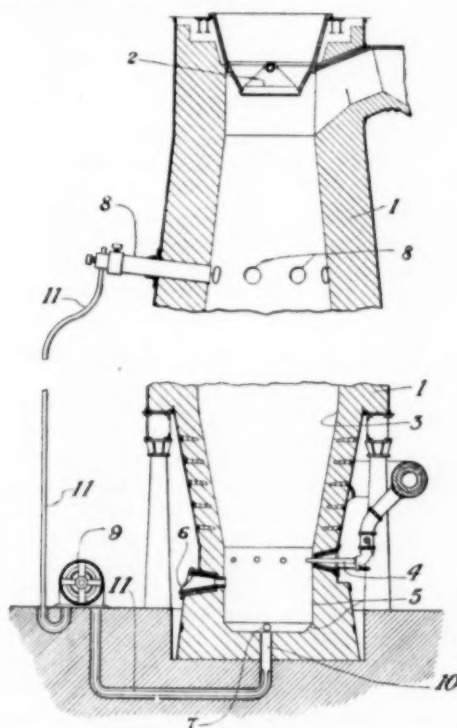


FIG. 2—CROSS-SECTION OF FURNACE

more conductors, or electrodes, 8, project through the furnace wall and are electrically connected by conductors 11 through a source of electric energy 9 with electrode 10, which passes through the wall of the crucible 5 and thus is in electrical contact with any metal contained in said crucible. In smelting iron ore, the furnace is charged as usual with ore, coke and limestone and smelted by blast. When sufficient slag and molten metal have been formed, the electric current is turned on. Electrolytic action as well as heat is claimed to aid in the removal of impurities from the molten metal (1,221,139, April 3, 1917).

Oil Cracking

Oil Cracking Apparatus and Process.—An electric-furnace cracking process is patented by LEON E. HIRT of Charleston, W. Va. A cross-section of the apparatus is shown in Fig. 3. Oil from the tank 7 is pumped up through pipe 12 to atomizer 13, where dry steam from pipe 13 atomizes the oil. The spray formed passes down through the expanded section of the furnace 3, and through the electrode region 4, where it is broken up into various constituents. The fractions obtained pass out through valve 16, which controls the pressure in the furnace. Any uncracked oil is trapped back into the

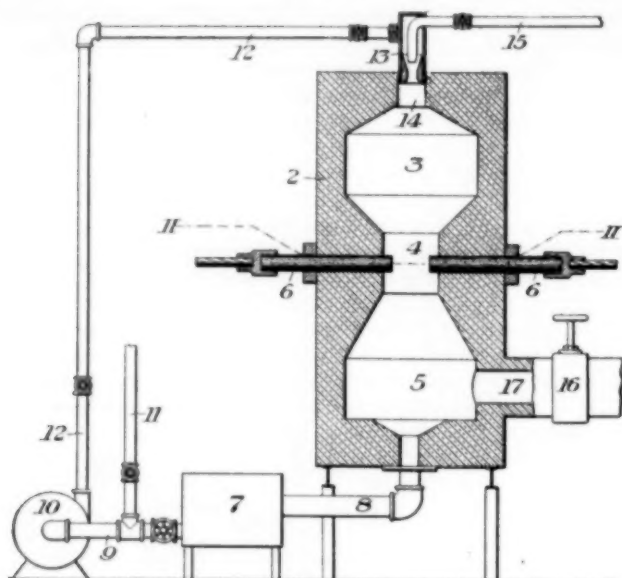


FIG. 3—ELEVATION OF CRACKING APPARATUS

tank through pipe 8. The furnace is cylindrical and is designed to operate either under pressure or vacuum (1,222,402, April 10, 1917).

Alloys

Use of Zirconium in Alloys.—Alloys based on the use of zirconium are patented by HUGH S. COOPER of Cleveland, Ohio (assigned to the Cooper Company of Cleveland, Ohio). Metals such as cobalt or nickel are hardened or toughened by adding varying percentages of zirconium. The product is also resistant to acids and alkalis and has a high electric resistance. When heated to 1150 deg. C. a protective oxide coating is formed on the outside. An alloy of 2 to 10 per cent zirconium, and the balance nickel, is stated to take a fine cutting edge. With 8 to 15 per cent zirconium and the balance nickel or cobalt the melting point of the alloy is decreased below that of nickel, or about 1400 deg. C., and the electrical resistance increased. With 16 to 30 per cent of zirconium the hardness is greatly increased and is useful for cutting tools. The melting point and tensile strength are lowered by increased amounts of zirconium, and the alloy cannot be worked by ordinary methods involving forging, drawing and rolling, but may be cast to produce lathe or cutting tools for working alloy steels, drill rod and bronze. The alloys can be made from zirconium ore, one grade of which contains about 73 per cent of oxide. An alumino-thermic method is used.

If it is desired to raise the melting point considerably, molybdenum is added. It is claimed that these alloys have the peculiar property of self-hardening and are ready for use when casted; that is, no treatment is necessary before use nor are they improved by any tempering process known. The alloy takes a beautiful polish which is not affected by gases of the atmosphere, nor corroded by alkalis or cold concentrated nitric, sulfuric, hydrochloric or boiling sulfuric acids, or cold dilute acids (1,221,769, April 3, 1917).

Aluminium-Soldering Compound.—A compound for soldering aluminium is patented by CHARLES A. STEWART of Carson City, Nev. The compound is an alloy of 69.07 parts tin, 28.77 parts lead, 1.44 zinc and 0.72 parts silver. These metals are melted together in the above proportions and the melt cast into sticks or rods for commercial use in aluminium soldering (1,222,158, April 10, 1917).

A Combined Steam Turbine and Centrifugal Boiler Feed Pump

The displacement of the reciprocating boiler feed pump by the centrifugal pump furnishes a good example of the necessity resting upon manufacturers of machinery for sustained technical development. The duplex boiler feeder, considered an improvement at the time of its introduction, some 50 years ago, because of its simplicity and more uniform delivery, was eventually taken up by numerous manufacturers, each of whom developed a complete line. The type became standardized, so that competition was close and severe. A comparison of the closely printed tabulations of sizes and models of duplex pumps, as catalogued by the dozen or so builders, will indicate the immense amount of money that was invested in drawings, patterns and manufacturing equipment, all now rendered practically obsolete, or at least greatly depreciated in value, by the perfection of the more compact, simple, reliable and efficient steam turbine-driven centrifugal boiler feeder.

Since it must handle a comparatively small amount of water against a relatively great head, the centrifugal boiler feeder should be fitted with small-diameter impellers running at high speed. It is therefore well adapted for steam-turbine drive.

In Fig. 1 is shown a 3000-hp., two-stage centrifugal boiler feeder combined in one casing and on one shaft with a velocity-stage steam turbine. This unit, which has been developed by the De Laval Steam Turbine Co. of Trenton, N. J., weighs only about one-tenth as much as a duplex reciprocating pump of the same delivery, and occupies only about one-eighth as much floor space and one-fifteenth as much cubical space.

The pump end contains two single-suction impellers, cast from a special bronze and carefully finished to exact contours. Two impellers are used for pressures up to 200 lb. per square inch, and three impellers for higher pressures. Single-stage boiler feed pumps have been built, but two or three stages are preferable because of the much longer life of the impellers at slower speeds. Each impeller discharges into a volute chamber by means of which the velocity in the water as it leaves the impeller is converted into pressure before the water is led to the eye of the succeeding impeller. This means of energy conversion is superior to the use of diffusion rings, as it is efficient over a wide range of delivery; and, more important still, does not involve the use of small and sharp parts like diffusion blades, which are subject to rapid erosion.

The pump is hydraulically balanced, and only one

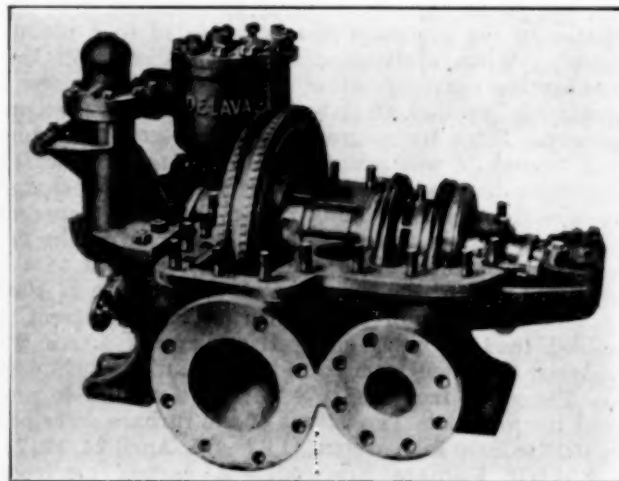


FIG. 1—CENTRIFUGAL PUMP WITH CASING REMOVED

pair of labyrinth rings surrounding the suction opening is required for each impeller, except the last, which has two sets of rings. The whole back of the impeller is subjected to a pressure equal to that existing at the periphery of the impeller, the same pressure acting on the front of the impeller, except for the area of the circle enclosed by the labyrinth ring about the suction opening. The last impeller, that is, the one from which the water is finally discharged, is equipped with two sets of wearing rings, one on the suction side and one on the reverse side of the web. As some water from the discharge of this impeller will leak between the wearing rings into the space back of the web, this impeller would be equally as unbalanced as the other impellers in the pump if there were no escape for the leakage water. To provide for diminishing the pressure in this balancing space as much as may be required to bring the whole series of impellers into balance, a leakage outlet is provided from which water can be conducted back to the suction of the first impeller.

The outlet leakage takes place between two collars, one attached to the casing and the other carried on the shaft. When the shaft moves toward the discharge end of the pump this escape is closed off and the pressure builds up in the balancing chamber. If the shaft, on the other hand, moves toward the suction, this escape passage is opened wider, allowing the pressure in the balancing chamber to fall and at the same time the in-leakage between the labyrinth wearing rings is decreased. By this means direct and positive balancing within very close clearance is secured with leakage of but a small amount of water. The so-called natural balancing secured by the use of double suction impellers in a multi-stage pump, is, in comparison, uncertain and imperfect, besides involving an extra long shaft, heavier impellers and two pairs of wearing rings to each impeller.

The labyrinth wearing rings are readily renewable, the stationary ring of each pair being held in a seat in the casing and the rotating ring being screwed upon the impeller. The reduction of leakage secured by the use of intermeshing labyrinth rings is highly important for securing high efficiency in pumps of comparatively small delivery. With the labyrinth type of ring the leakage path is so tortuous that very little water escapes even at high heads, although ample clearance is provided to take up expansion and contraction due to changes in temperature.

The suction end of the pump is adjacent to the turbine, and the shaft packing between the turbine and pump chambers is hence subjected to turbine exhaust pressure on one side and the suction pressure on the other. A simple packing is therefore sufficient, and in any case any small leakage of steam in one direction, or of water in the other, does no harm. As the leakage space adjacent to the balancing chamber at the discharge end of the pump is connected back to the pump suction, the packing about the shaft is subjected only to suction pressure. Aside from the intermediate packing already mentioned there is only one steam packing, which is subjected to exhaust pressure.

The steam end of the unit consists of a velocity-staged turbine with either two or three rows of moving buckets, according to the steam economy desired. The nozzles can be proportioned for either high-pressure steam exhausting to feed heater, or to condenser for low-pressure steam exhausting to condenser, or the unit can be made interchangeable, thus permitting of a great degree of flexibility in plant design. Where the exhaust steam from the boiler feeder is consumed in heating feed water the thermal efficiency of the turbine-driven boiler feeder is much greater than that of a

boiler feeder driven by electric motor, or even than that of the main unit itself.

The unit is ordinarily fitted with a speed governor mounted upon the end of the shaft, and when running at constant speed the head varies with the delivery, as shown by the curved characteristic in the accompanying chart. As will be seen, the rise in pressure at reduced capacity is not excessive. Ordinarily, however, a pump governor controlled by the pressure at some point in the feed line near the boilers is employed to control the speed, giving a practically uniform pressure at all deliveries, as shown by the lower and straight line in the chart. In case of failure of the pressure governor to operate, the control of the unit is automatically taken over by the speed governor.

However, to provide against any possibility of racing, an emergency governor is also fitted. This consists of a pin contained within a hole bored diametrically through the shaft. This pin is held by a spring from flying out under the influence of centrifugal force. When the speed reaches a certain point the spring is compressed so that the pin strikes a trip, releasing another spring by which the governor valve is closed at once and completely. Racing and excessive overpressure are therefore impossible. The normal speeds of these pumps vary from 1800 to 3500 r.p.m., according to pressure and capacity, and, due to the heavy shafts employed, are far below the critical speeds.

The bearings are of the straight, ring-oiled type, and, like other parts subject to wear, such as the pump impellers, turbine rotor labyrinth rings, and governor valves, are built to a limit-gage basis, so that they are all interchangeable. The entire rotating members and all wearing parts, with the exception of the governor valve, are accessible for inspection or removal upon lifting the casing cover and taking off the bearing caps, all of which can be done without breaking steam or water-pipe connections.

In specifying the capacity of boiler feeders, the temperature of the water to be pumped should always be stated, as the capacity is nearly 50 per cent greater with water at 75 deg. F. than with water at 210 deg. F. For the same reason, capacity and efficiency tests of a pump should be carried out with water at the temperature at which it will be received by the pump when in actual service.

Survey of California's Resources.—The State Mining Bureau of California under the direction of Fletcher Hamilton, State Mineralogist, is starting a field campaign to report on the economic minerals of California which have an important industrial and military bearing on the present war situation. For the past four years the Bureau has been working on a complete survey of the entire State's mineral resources by counties, field work for which is now practically completed and the results in part published. Particular interest and value attaches at the present moment to the available supplies of chrome, coal, iron, magnesite, manganese, molybdenum, quicksilver and tungsten. The extent and availability of the petroleum resources, which are so important in modern naval operations, have already been thoroughly covered by the Bureau in its work of protecting the fields from damage by faulty operations. As data on the other minerals are already well in hand, trained geologists and engineers of the Bureau's staff are being sent out to bring the information down-to-the-minute with relation to the latest developments in the above-named items. The report will cover the location, size, accessibility to transportation, character, quality, and state of development of every known deposit throughout the entire state.

New Design of Dust Collector

The elimination of dust from hot flue gases has been difficult, and has received a great deal of attention during the last few years. There have been many dust collectors developed, and the electrical precipitation method has also been adapted to many dust and fume-collecting problems.

In the ordinary type of dust chamber, where baffles are used, a velocity not exceeding 5 ft. per second has been found the best for settling dust. The majority of dust chambers have not been found efficient, as there is always a certain amount of current in the gas which keeps the finest particles in motion and carries them beyond the chamber. Various methods have been used: hanging wires, horizontal plates, inverted half cylinders, etc., where the dust built up due to the large obstructing area, but without entirely stopping the current of air.

A dust collector patented Jan. 2, 1917, by Wm. Robertson, has several novel and interesting features. The gas passes over troughs which form a "dead air space," and it is claimed that the dust falls with no current to disturb it and carry it along. A cross section of the apparatus is shown in Fig. 1.

The gas enters at the top at the left where marked "inlet," and passes down around the trough-shaped baffles. When gas is passing through the chamber these baffles are closed, as shown at the right. The dust which falls in the dead air space above the troughs, is collected in the troughs, and these are emptied periodically by lowering one side of the trough, as shown at the left. This is one of the interesting features of the

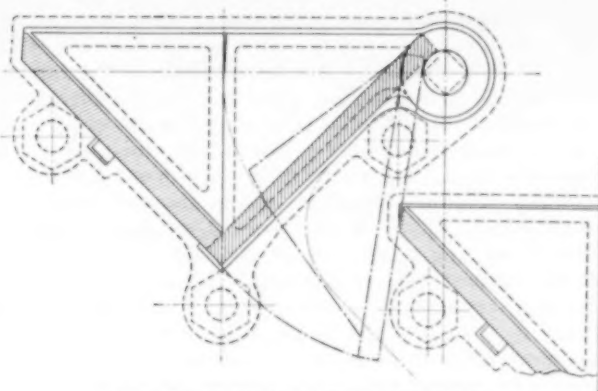


FIG. 2—DETAIL OF DUST TROUGHS

collector, and a detail of the trough is shown in Fig. 2.

As shown in this drawing, the right side of the trough is lowered and strikes the left side of the adjacent trough, thus helping to knock off the dust which might cling to the trough. By opening a whole vertical set of troughs at one time a free path is formed for the dust to drop to the bottom. One section of the chamber is closed and gas passes through while the other is open for emptying.

The dust can be removed from the bottom by a screw conveyor.

An end view of the chamber is shown in Fig. 3. At the left is shown a wheel for emptying the troughs. The design has later been modified so as to have the emptying done by lever in order to get a quick drop and the consequent knocking effect, and each ver-

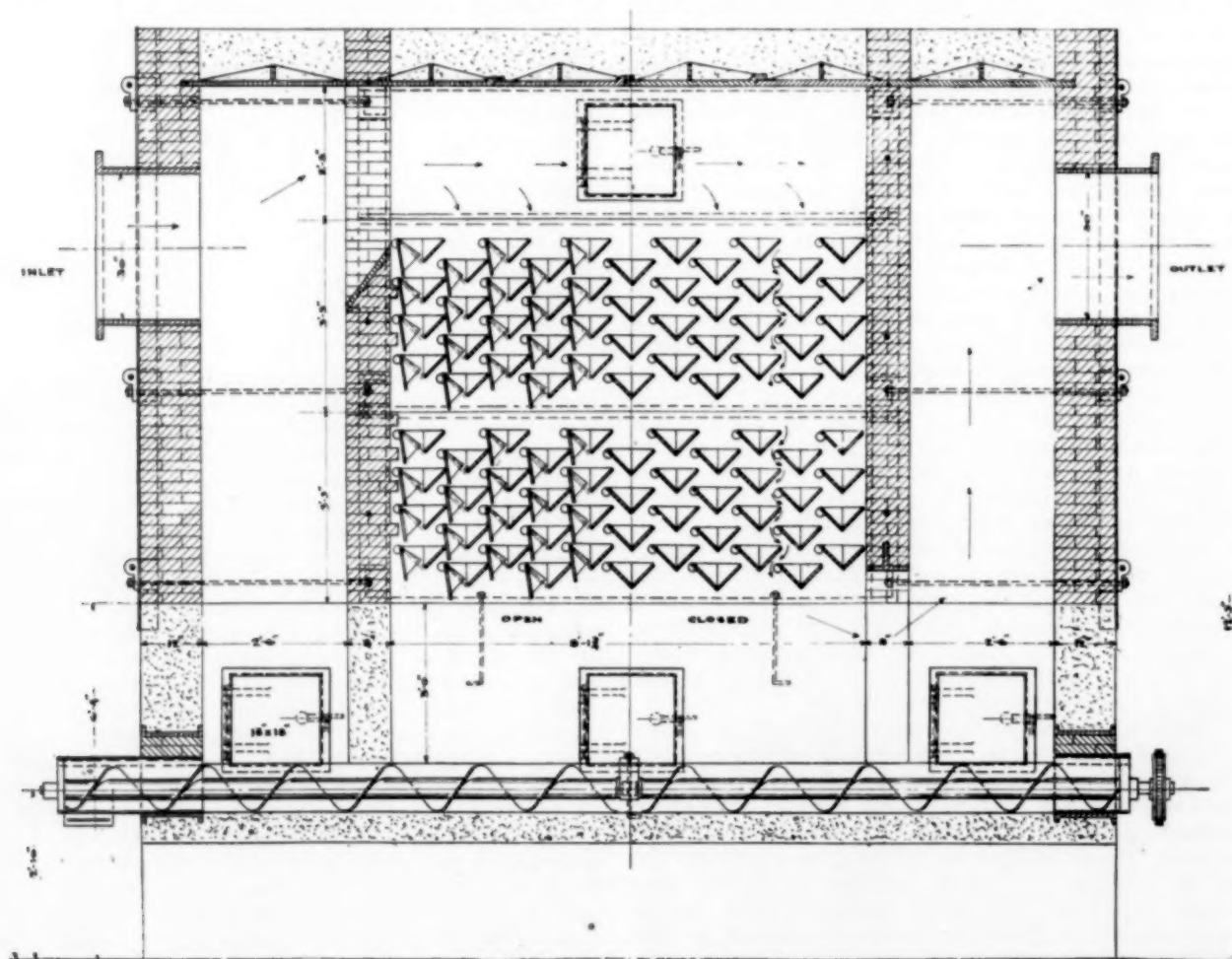


FIG. 1—SIDE ELEVATION OF ROBERTSON DUST COLLECTOR

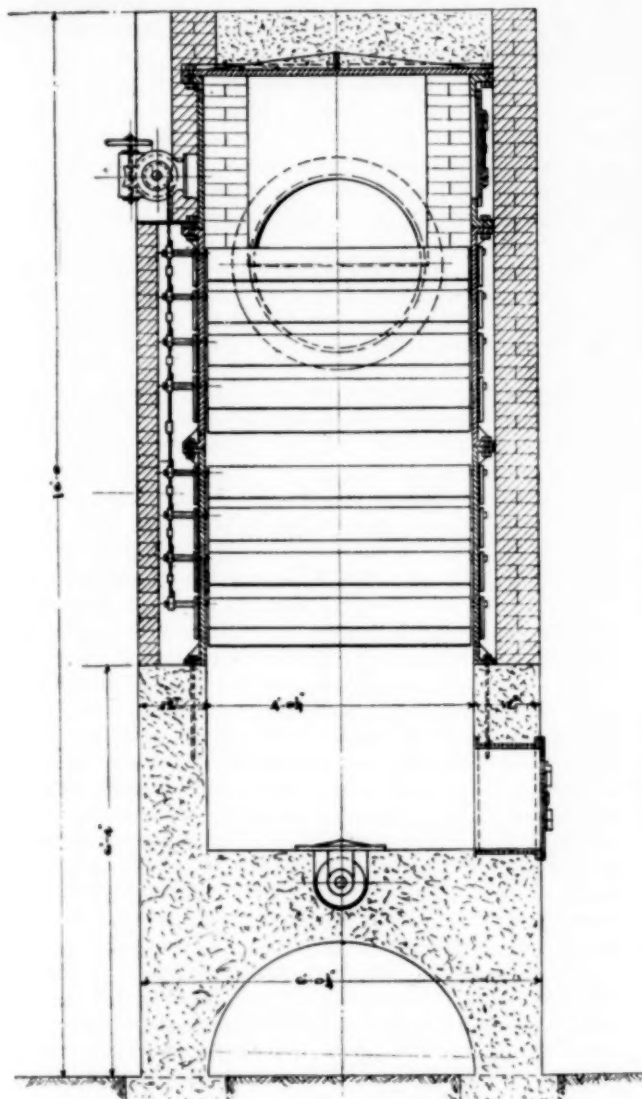


FIG. 3—END VIEW OF ROBERTSON DUST COLLECTOR

tical row of troughs is operated by a separate level.

The chief features of the collector are the "dead-air space," the easy dumping methods and the trough design of the baffles.

New Foundry for Iron and Steel Castings

The Lunkenheimer Company of Cincinnati, Ohio, manufacturer of high-grade engineering specialties, has recently added to its plant a new foundry and pattern shop for the casting of products made of ferrous materials.

The new foundry occupies an area of 36,000 square feet and the pattern storage building an area of 18,000 square feet, the latter building being four stories in height. Both the buildings are of reinforced concrete. Provision has been made to add two more floors to the pattern storage building and the wall at one end of the foundry is so built as to enable easy removal to further extend this building when more space is required. Excellent light and ventilation is afforded by the saw-tooth roof construction of the foundry together with the large number of Fenestra windows used. A sprinkler system has been installed and wherever possible fireproof material is used throughout the building. The floor of the foundry building is of creosoted wood block which is stated to make an excellent smooth surface, exceptionally durable and easily repaired. A wash room for the employees adjoins the foundry. A sufficient num-



GENERAL VIEW OF FOUNDRY

ber of shower baths are also provided for the employees and all have their own steel lockers.

For the melting of iron, a cupola having a capacity of ten tons per hour is used. The molten metal is poured from the cupola into large crucibles mounted on wheels which are pulled on rails to the destination intended. These large crucibles can be tilted in order to fill the small ladles used in pouring the metal in the molds. Compositions of other ferrous materials are melted in revolving furnaces of the company's design.

Six traveling cranes, the majority of which are electrically operated, are provided for handling the heavy work, and all appliances necessary for the efficient operation of an up-to-date foundry are present and arranged in systematic relation to each other.

Directly in the rear of the foundry is a railroad from which a spur is run to a concrete storage house in which sand, coke and other materials are kept.

In order to save time a large part of the material and machinery was moved from the old foundry building to the new one, a distance of about a city block, during the period from Saturday noon, March 24, to Monday morning, March 26, thus enabling many molders to continue their work without loss of time.

Book Reviews

Blast Furnace Construction in America. By J. E. Johnson, Jr. 415 pages, 247 illustrations. Price, \$4 net. McGraw-Hill Book Co.

Probably no living person is qualified for so many different reasons to write a book on this subject as is J. E. Johnson, Jr. His father was an important American ironmaster and this author may be said to have been born and bred around a blast furnace. For more than twenty years he has held a prominent position as operator, inventor, author, and interpreter. Two of his achievements in the latter capacity would alone be sufficient to place him in the first rank of modern scientific interpreters; namely, his theory of the constitution of cast iron, which has since been expanded and elaborated by himself and others, and his theory of the critical temperature of the blast furnace, which is now generally accepted as the explanation of the saving effected by drying blast, which was once considered (especially by German theorists) as super-theoretical and, therefore, impossible. A deep thinker, the author nevertheless uses exact and clear language, which makes the text easy reading for everyone and within the grasp of any intelligent furnace man.

This volume deals chiefly with the mechanical side of the blast furnace and will be followed by another book treating the subject from the metallurgical viewpoint. This book would be correctly classified as a book of reference, because of the comprehensive nature of the contents and the detail into which the text enters, but it is also suitable for use as a textbook for students or practitioners wishing to acquire a thorough knowledge of the subject. The contents include fundamental conditions, definitions, classification, handling of the raw materials and products, mechanical equipment, such as boilers, blowers and hoisting apparatus, water supply system, pumps, electric supply and so forth; also a comprehensive study of hot-blast stoves and the construction of the stack.

A chapter is devoted to each of two very important subjects, namely, The Cleaning and Washing of Gas and the Drying of Blast, including a critical study of the different processes for drying with, a glimpse into the future and the advantage of the different systems.

The book is strongly recommended to every blast furnace man and to those interested in blast furnaces.

BRADLEY STOUGHTON.

* * *

The Founder's Manual. By David W. Payne. Octavo (11 x 19 cm.), xi + 676 pages, 245 illustrations, flexible black morocco binding; price \$4.00 net. New York: D. Van Nostrand Company.

The author, editor of *Steam*, with many years' foundry experience, compiles a great mass of information scattered through technical journals, transactions of societies, and special books. A preliminary portion of the book, intended largely for beginners, relates to elementary mathematics, mechanics, etc., taken from standard text-books and trade publications. The remainder, the foundry part, contains a vast amount of information, not very carefully selected and not logically arranged.

Much of the tabular information is quoted from old books and contains inexact or even grossly erroneous data; e.g., the boiling point of sulphur given as 570 deg. Fahr. instead of 833 deg.; melting point of mercury 39 deg. Fahr. instead of -39 deg.; latent heat of fusion of aluminium 28.5 instead of 90; the combining equivalents of the elements given as so many degrees centigrade (!) (H = 1 deg. C., O = 8 deg. C., etc.).

Aside from these unreliable tables, the practical information on all phases of foundry practice and its supplementary arts is at places very good and at others misleading or incomplete. Those so expert in physics, chemistry, metallurgy and foundry practice that they are safe from being misled by the misinformation so liberally sprinkled throughout it, will be able to make good use of those portions of the book which are indeed very good.

* * *

Annual Chemical Directory of the United States.

Edited by B. F. Lovelace. 365 pages. Cloth. Price \$5, postpaid. Baltimore: Williams & Wilkins Company.

This is the first appearance of a separate chemical directory which has aimed to cover the entire field of products, equipment, institutions, societies, publications and engineers. A very good attempt has been made in this book to collect and classify information which should prove very useful as a reference work. It is the intention to issue it once a year.

The first chapter contains a list of American manufacturers and dealers in chemicals. The companies are listed under the products alphabetically by states. The compilation of such a list is a laborious and difficult task and it can hardly be expected to be com-

plete. The compiler should have the assistance of all the manufacturers and dealers in order to make the list as complete as possible.

The second chapter contains a very good list of manufacturers of and dealers in apparatus and equipment for plants and laboratories. The information is carefully indexed and covers 105 pages. Some of the items such as abrasives and acetylene gas, it would seem more logical to list under the products in Chapter I.

Chapter III contains a list of analytical chemists, consulting chemists, and chemical engineers. There is room for considerable improvement in this chapter. The list of consulting chemists is surprisingly incomplete, as is also the list of chemical engineers, which consists mostly of equipment manufacturers. Many firms and individuals are listed only as analytical chemists which also belong in the other lists. It would seem more logical to combine the headings Consulting Chemists and Chemical Engineers under one heading, as the distinction is not clear. Or if the distinction is to be kept up, exact definitions of consulting chemists and chemical engineers should be given.

In Chapter IV there is another heading, Industrial and Professional Laboratories. It would seem that there is duplication here with Chapter III.

The American and foreign colleges and universities offering courses in chemistry are listed in Chapter V. This is a splendid idea and is something that should prove very valuable. It would be still more valuable if it were possible to state under each college whether or not the course includes chemical engineering.

The list of experiment stations in Chapter VI seems to include only agricultural stations. This should include many other engineering experiment stations which carry on chemical investigations and also the Bureau of Mines stations.

The remaining chapters contain lists of Federal officials of dairying, food, drugs, health and feeding stuffs bureaus, technical and scientific societies and journals, and a few pages of chemical developments in 1916. The last-named department seems superfluous in a work of this kind and it would seem more desirable to bring the other departments up to a higher standard rather than try to do too much. The authors and publishers are to be congratulated on their efforts to do something worth while for chemistry in this country, and it is to be hoped that they will receive much co-operation in the preparation of subsequent editions.

* * *

Operation of Gas Works.—By Walter M. Russell. Octavo (15 x 23 cm.), 209 pages, 76 illustrations. Price, \$2.00. New York and London: McGraw-Hill Book Company, Inc.

This is a book describing ordinary American practice, for the use of a foreman, superintendent, engineer or cadet, in a small or medium-sized gas works. It is not accurate or scientific enough, or sufficiently up-to-date, for the use of anyone connected with a large, modern plant. The chemical explanations are weak, but the details of practical management are good. Within the limits noted the book has a mission.

Bureau of Mines Station at Golden, Col.—The equipment and installation of the technologic laboratory at Golden have been almost completed. The laboratory is designed to handle rare metal ores in quantities from 10 lb. to 500 lb. It is designed to make any kind of acid leach; any kind of an alkaline or salt leach, and any kind of a fusion. In addition a small wedge type roasting furnace has been installed as well as a tube furnace which can be used either for oxidation or reduction.

Personal

Prof. G. H. Clevenger of Leland Stanford University, California, has been appointed research professor in metallurgy and will relinquish his elementary and routine teaching.

Mr. R. E. Conder of the Boston Woven Hose and Rubber Co. gave a talk on the manufacture of rubber and its products before the Technology Club of New York on Friday evening, May 25. Mr. Conder also showed some interesting moving pictures.

Mr. James F. Couch was elected president of the recently organized Des Moines Chemical Society at the regular meeting on April 9.

Messrs. A. E. Drucker and G. W. Laurie have opened an office at 30 Church Street, New York, as consulting metallurgical engineers under the name of Drucker & Laurie.

Mr. John F. Hale, for eleven years assistant manager of Warren Webster & Co., Camden, N. J., and for nine years previously vice-president of the Consolidated Engineering Co., Chicago, is now with the Braemer Air Conditioning Corporation of Philadelphia in an official capacity. Mr. Hale was a former president of the Society of Heating and Ventilating Engineers.

Mr. F. A. Lidbury, manager of the Oldbury Electrochemical Company, Niagara Falls, N. Y., was elected president of the Engineering Society of Buffalo at a meeting held Wednesday evening, May 9.

Dr. H. N. McCoy, who has been connected with the chemistry department of the University of Chicago since 1901 and professor since 1911, has resigned and will devote his time to his important technical interests. His process of extracting radium from carnotite is being used by the Carnotite Production Company of Chicago, in which he is a director. He is also interested in the production of thorium and related products and is a director of the Lindsay Light Company of Chicago, large producers of thorium.

Mr. Guilford D. Scholl, formerly with the United States Metals Refining Company, the Electrolytic Refining & Smelting Company of Australia, Ltd., and the experimental leaching and electrolytic plant of the Copper Queen at Douglas, has resigned as construction superintendent for the Walter E. Lummus Company of Boston, Mass., to become superintendent of the electrolytic zinc plant of the River Smelting & Refining Company, at Keokuk, Iowa.

Messrs. W. H. Seagrave and W. E. Dunkle, consulting engineers, have recently formed a company to be known as W. H. Seagrave Company, with offices in the L. C. Smith Building, Seattle, Wash. Both members of the firm are well-known mining engineers, Mr. Seagrave having been the manager of the Kennecott Copper mines of Alaska, and Mr. Dunkle the field geologist and traveling representative of the Alaska Syndicate.

Mr. A. R. Topping has been elected secretary of the Walter A. Zelnicker Supply Co. of St. Louis, Mo. He has been associated with the company for the past eleven years.

Mr. Thomas Varley, flotation expert of the U. S. Bureau of Mines, has recently visited the Seattle station of the Bureau of Mines and College of Mines of the University of Washington. A thorough inspection of the equipment of the college laboratories has been made, to be used by the local station in research work.

Mr. Ernest Wittenau has been appointed assistant-superintendent of concentration at Clifton and Morenci for The Arizona Copper Co., Ltd.

CURRENT MARKET REPORTS

The Iron and Steel Market

While the steel market has given no patent exhibition of its being on a new tack there is every reason to believe that a new order of things marketwise is arriving. Advances in finished steel prices in the past two or three weeks have been relatively unimportant. While such a short period does not furnish a criterion, since throughout this movement there have been spurts in price advances, interspersed with periods of a few weeks of almost stationary prices, the character of the business being done, and the attitude of both buyers and sellers, is suggestive that the steel market is entering a new period.

The tonnage of steel business being entered on order books is no doubt, roughly speaking, equal to the output in shipments against old orders, but the character of the business is changed. There is less business in the form of specific orders, for a given purpose, and more in the form of the ordinary open contract, subject to future specification, this buying being by jobbers and ordinary manufacturing consumers. It is to be presumed that in the event of a break in prices the contracts would be adjusted to suit the conditions.

It is characteristic of the American steel market that it is difficult for it to remain at a fixed level for any length of time, unless perchance the level is one fixed by the cost of production, and that when prices cease advancing they begin to get weak. The market is strong only when it is advancing. After a period of advances the existing contracts are at less than the then current market rates and buyers continue to receive their shipments because the steel is cheaper than what could be bought in the open market. On an average, the current deliveries of finished steel products are at between \$20 and \$30 a net ton below the present market rates for forward deliveries.

Assuming the difference is \$25 a ton, and observing that since March 1 steel prices have been advancing at an average rate, to set it conservatively low, of \$6 a ton, a continuance of this rate would add about \$25 a ton in four months, or by Oct. 1, so that prices paid on Oct. 1 for future delivery would be \$50 a ton higher than those now being paid on actual shipments. The total output of finished steel is about 3,000,000 net tons a month, and \$50 a ton added would make \$150,000,000 per month additional to be paid, approximately the amount Congress sought to raise with war taxes upon the whole people, and regarded in many quarters as a heavy burden. Obviously the people would find difficulty in paying such an amount to the steel industry. Of course, long term contracts, exports, and sales to the Government would have to be counted out, but still the comparison affords food for thought.

High prices for steel, high labor costs and labor scarcity, together with various war uncertainties, made it that much less than the usual proportion of steel is going into permanent structures, representing investments. Correspondingly more is going to support the common every-day activities of the people, with plenty of money to spend. The big people, the quick thinkers, readily acquired a view of what our entrance into the war meant industrially and economically. The rank and file of the people are not yet awake, but as knowledge comes to them their expenditures involving directly or indirectly the consumption of steel are likely to decrease, and since the war started they have been the chief consumers. All exports have involved not more than 25 per cent of the production, at the outside. The prospective buying of the European Allies will serve largely to replace contracts that have lately been ex-

piring, and in the next twelve-month the total movement abroad may be heavy without its exceeding 25 per cent of our capacity. The requirements of our Government appear large, but with 3,000,000 net tons a month capacity the percentage is necessarily low.

The scarcity of steel is quite pronounced, but the steel for which customers are begging the mills is steel for which engagements, down to the ultimate consumer in many instances, were entered into long ago. Steel is certain to be scarce for months, by reason of the existing pressure for it all along the line, but with the country actively engaged in war the pressure from the ordinary ultimate consumer can hardly continue indefinitely, particularly at such high prices. With price recessions at intervals the demand might be stimulated.

STEEL FOR GOVERNMENT

The 1917 naval program of the Government, for which steel was arranged about two months ago, involved a trifle more than 400,000 tons, in ship plates, structural shapes, bars and structural work for navy yard extensions. In miscellaneous orders since placed perhaps 200,000 tons more of steel has been taken up. A large tonnage of sheets, possibly running into six figures, is being arranged. The Shipping Board's program for the building of small steel freighters, in addition to the much advertised wooden freighters, is thought to involve about 40,000 tons of plates per month. The present plate rolling capacity, for plates of the thickness and width required, is estimated at about 125,000 tons a month, with perhaps 75,000 tons a month in prospect, at an average date six or eight months hence, as mills under construction are completed. Apparently nothing has been done as to shells or shell steel, and this may run into a considerable tonnage.

PIG IRON AND STEEL

While the prospects seem to be that spectacular advances in finished steel prices have come to an end, there are various realignments that may occur. Up to date billets per gross ton and finished steel products per net ton, have advanced by about the same amount, say \$60 to \$75 a ton, depending largely upon what deliveries one selects for comparison, while pig iron has advanced much less. In other words, there has been sufficient finishing capacity for all the semi-finished steel that could be produced, and plenty of pig iron for all the steel works. Of late the alignment has been changing, through steel making capacity increasing more rapidly than blast furnace capacity, while stocks of pig iron were used up some months ago. The present trend is for pig iron rather than steel to be the scarcer article, particularly as the current outcome of scrap is especially small in proportion to the output of steel. At the low point pig iron was \$13 to \$14 a ton against billets at \$19 to \$20. Now pig iron is \$42 to \$45 with billets \$90 to \$95, and pig iron may come much closer to billets. If demand continues, as it certainly will for many months, the steel mill will if necessary pay for pig iron the billet price less the cost of conversion rather than reduce the steel output.

Non-Ferrous Metal Market

Wednesday, May 23.—There is little change in prices of any of the common metals, except lead, which was advanced \$10 per ton on May 17. The tin market is strong, and the situation in spelter has improved. In the case of copper there seems to be a disposition to wait for Government developments as to price.

Tin.—Tin has advanced considerably, and Straits is now quoted at 65 to 66 cents. Some consumers are

carrying large stocks owing to the British regulations preventing them from reselling. This situation should be remedied, as some consumers cannot now use tin which they bought for cans. It is believed that the 10 per cent duty will be applied to tin. The foreign market is also strong, and has advanced considerably.

Spelter.—It is reported that the Government paid 11.50 cents for high grade, 11 cents for intermediate, and 9 cents for prime Western, for 10,000 tons. The demand for spelter is still at a very low level and ore prices remain high. Sellers are not offering large quantities, however, and this tends to keep the market fairly firm. Prompt spelter is held at 9.50 to 9.75 cents.

Copper.—The copper market has been very dull, with buying at a low ebb. Every one seems to be waiting until the Government price is settled. In the meantime, electrolytic and lake are both quoted at 32 to 32.50 cents for prompt shipment.

Lead.—The scarcity of lead still continues, and on May 17 the trust price was advanced \$10 per ton to 10 cents. The Government price had not been decided on at the time of writing.

Other Metals.—Antimony is practically unchanged at 25 cents for Chinese and Japanese. Aluminium is unchanged at 59 to 61 cents. Magnesium, unchanged, \$2.50 to \$3.00. Quicksilver, \$102.50 per flask. Pure platinum, \$105. Palladium advancing, and now \$105. Silver, 74 $\frac{3}{4}$ ¢. Tungsten ore, \$17 to \$17.50 per unit.

Chemical Market

COAL TAR PRODUCTS.—There has been a light movement in all coal-tars during the fortnight, and prices have as a rule remained practically unchanged; there have been a few items that were subject to slight upward turns, however, and a few of the intermediates because of the light consuming demand were reduced under selling competition. The possibility of a 10 per cent duty on all imported goods that have been on the free list and a 10 per cent advance on dutiable merchandise has had a somewhat disconcerting effect on the market, as holders of imported goods have in some cases been induced to hold off from purchasing, and buyers who would otherwise have held their orders back have seen fit to cover in part for future requirements.

Benzol.—Due to the fact that producers have been expecting government business they have been conserving supplies by restricting their outside business to regular customers only; it is now apparent, however, that no large purchases of picric will be made for government account, and as some leading producers now have accumulations, car-lot business is not so tight as previously, and producers are making some concessions for immediate business.

Aniline Oil and Salts.—There has been a fairly steady tone to the market, and some makers are holding their prices up; there have, however, been a few lots offered on this market at comparatively low price, and these have had a rather depressing effect on the situation; much of the low-priced goods, however, have been picked up and the market is assuming a firmer tone. There has been good inquiry for the salts, and sellers are holding firmly at slightly increased prices; while a few manufacturers of the oil who had been forced out on account of the low prices have again resumed operations, the output of the salts has not increased materially.

Para Nitraniline.—There is a fair demand in evidence, although a slight overproduction is responsible for the slightly easier feeling; prices have in consequence been slightly lower. There are but a couple of makers of the *Meta Nitraniline*, and demand at this time is fairly active.

Toluol.—The offerings are still restricted, and makers are having difficulty in taking care of regular consuming demand; added to the steady absorption of the product is the fact that further orders of T. N. T. are expected to be placed by the government, although purchases for the immediate future will be light. The order recently placed for 850 tons was divided between the DuPont Co., Sement Solvay Co., and the Nitro Powder Co. One of these makers has been forced to buy toluol in the open market to fill part of their requirements. The prices at which the business was taken are low, and it is evident that explosives makers are willing to co-operate with the government in this important matter.

Ortho and Para Toluidine.—The latter particularly has been subject to strong demand, although the fact that production has increased has prevented prices from advancing further. New makers in moderate quantities are securing better yield of the *para* in proportion to the yield of *ortho*. The latter product, however, is being offered in some directions at slightly lower prices.

Phenol.—The situation is not particularly strong, due to the fact that while production has gone on steadily there has not been an important demand, and supplies have in some cases accumulated; occasional export orders, however, have helped the situation, however, and one order for 100 tons for the Orient is now in the market. Very little further progress has been made in the manufacture of phenol derivatives, and such products as *para nitro phenol*, *diphenylamine*, *meta phenylamine diamine* have been in good demand, while production is limited, and confined to a few manufacturing centers.

Naphthalene.—The flakes have been subject to somewhat wider demand, and some makers of the prime white flakes are sold up on contract, prices however have moved within narrow margins; several lots of English flakes are held in bond, which because of the 15 per cent ad valorem and 2c. per lb. specific duty, have been offered for export only; the prices in bond are somewhat below the prices quoted for domestic goods.

Nitro Naphthalene.—Demand is very limited, and makers have been induced to make concessions for firm business; *dinitro naphthalene* is not offered with so much freedom, as makers are using the product in the manufacture of *alpha naphthylamine*. There is fair export and domestic demand for this latter product, although the entrance of new makers into the field has caused a reduction of prices.

Naphthylamine Di Sulphonic Acid.—(1:3:6 Acid)—This product is now being made on a moderate scale by large manufacturers, who expect to develop a fairly wide field for it.

Xylol.—There is a fair demand for this product, although the commercial and some of the higher grades are offered by large makers at slightly lower figures. The *Solvent Naphthas* are rather weak, as demand is not particularly strong, and important accumulations are held by big factors. Manufacturers are endeavoring to widen the scope of the use of the light naphthas by using as a substitute for turpentine.

Salicylates.—The demand for the manufacture of *Acetyl Salicylic* and for medicinal use has caused an exceedingly strong market, as supplies are near the vanishing point; the new makers are endeavoring to their utmost to supply immediate requirements.

HEAVY CHEMICALS

The market has been quiet, with the exception of a half dozen or more of the items that come under this classification. The falling off in export business has been the chief reason for this, and shipments to Europe are particularly light at this time; the South American

trade however has progressed in a moderately satisfactory manner.

Soda Ash.—The market has been rather weak, as export shipments have been light, and consuming demand has not materially widened. The tightness of the cooerage situation has induced manufacturers to put up ash in bags to a greater extent than previously, with the result that prices in bags have lessened, and the differential between prices in barrels and bags is greater than ever before in the history of the industry.

Caustic Soda.—A heavy speculative demand has forced prices up, and spot or nearby deliveries are now held at considerably over 6c.; contract business for the balance of the year, and over 1918 is progressing steadily, at higher levels.

Bleaching Powder.—Prices have slumped rapidly during the last two weeks, and both domestic drums and goods packed in export containers offered freely at lower prices; a purely buyer's market prevails, and on real business the purchaser could almost establish his own price.

Bichromates of Soda.—This highly manipulated market has been rather quiet lately, and concessions are made for export business. Makers are endeavoring to hold up the price for domestic consumption, and in some cases makers have been buying back their supplies in small lots. The *potash* has held steadily at prices that have not varied much.

Cyanides.—The markets on *soda* and *chloride mixture* have weakened considerably, due to the presence of English goods in the market, the absence of heavy demand, and the fact that domestic manufacturers are getting ready for placing on the market the output of their new plant.

Formaldehyde.—Heavy demand, and the absence of spot supplies on the market, has caused considerable strength, and advances have been more or less rapid.

Arsenic.—Makers are sold far ahead, on carlot business, and the limited offerings for nearby delivery are held at high prices. Demand is heavy from Paris green makers.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET MAY 22, 1917

Acetic anhydride.....	lb.	1.50	—	1.75
Acetone, drums.....	lb.	.27	—	.27½
Acid, acetic, 28 per cent.....	lb.	.05	—	.05½
Acetic, 56 per cent.....	lb.	.09½	—	.10
Acetic, glacial, 99½ per cent, carboys.....	lb.	.29	—	.30
Boric, crystals.....	lb.	.11	—	.11½
Citric, crystals.....	lb.	.73½	—	.75
Hydrochloric, commercial, 18 deg.....	lb.	.01½	—	.01½
Hydrochloric, 20 deg.....	lb.	.01½	—	.01½
Hydrochloric, C. P., conc., 22 deg.....	lb.	.01½	—	.01½
Hydrofluoric, 30 per cent, in barrels.....	lb.	.04½	—	.05
Lactic, 44 per cent.....	lb.	.11	—	.12
Lactic, 22 per cent.....	lb.	.04½	—	.05
Nitric, 36 deg.....	lb.	.06½	—	.07
Nitric, 42 deg.....	lb.	.07½	—	.08
Oxalic, crystals.....	lb.	.44	—	.46
Phosphoric, 85 per cent.....	lb.	.33	—	.37
Picric.....	lb.	.70	—	.75
Pyrogallol, resublimed.....	lb.	3.50	—	4.00
Sulphuric, 60 deg.....	ton	20.00	—	22.00
Sulphuric, 66 deg.....	ton	30.00	—	35.00
Sulphuric, oleum (Fuming), tank cars.....	ton	38.00	—	40.00
Tannic, U. S. P., bulk.....	lb.	.45	—	.50
Tartaric, crystals.....	lb.	.79	—	.82
Alcohol, grain, 188 proof.....	gal.	3.05	—	3.07
Alcohol, wood, 95 per cent.....	gal.	1.00	—	1.02
Alcohol, denatured, 180 proof.....	gal.	.70	—	.72
Alum, ammonia lump.....	lb.	.18½	—	.04½
Alum, chrome ammonium.....	lb.	.40	—	.45
Alum, chrome potassium.....	lb.	.12	—	.12½
Alum, chrome sodium.....	lb.	.06½	—	.07
Alum, potash lump.....	lb.	.02	—	.02½
Aluminium sulphate, technical.....	lb.	.03	—	.03½
Aluminium sulphate, iron free.....	lb.	.06	—	.07
Ammonia aqua, 26 deg. carboys.....	lb.	.13	—	.14
Ammonium carbonate.....	lb.	.16	—	.17
Ammonium nitrate.....	lb.	.05½	—	.06
Ammonium sulphate domestic.....	gal.	4.00	—	4.25
Amyl acetate.....	lb.	.18	—	.19
Arsenic, white.....	lb.	.30	—	.60
Arsenic, red.....	ton	85.00	—	90.00
Barium chloride.....	ton	85.00	—	90.00

Barium sulphate (Blanc Fixe, powder).....	lb.	.04	—	.04½
Barium nitrate.....	lb.	.11	—	.11½
Barium peroxide, basis 70 per cent.....	lb.	.27	—	.27½
Bleaching powder, 35 per cent chlorine.....	lb.	.03	—	.03½
Borax, crystals, sacks.....	lb.	.08	—	.08½
Brimstone, crude.....	ton	45.00	—	—
Bromine, technical.....	lb.	.80	—	.90
Calcium, acetate, crude.....	lb.	.03	—	.03½
Calcium, carbide.....	ton	80.00	—	90.00
Calcium chloride, 70-75 per cent, fused, lump.....	ton	26.00	—	28.00
Calcium peroxide.....	lb.	1.80	—	1.90
Calcium phosphate.....	lb.	.30	—	.31
Calcium sulphate.....	lb.	.01	—	.02
Carbon bisulphide.....	lb.	.04½	—	.04½
Carbon tetrachloride, drums.....	lb.	.15½	—	.16
Caustic potash, 82-92 per cent.....	lb.	.76	—	.78
Caustic soda, 76 per cent.....	100 lb.	6.15	—	6.25
Chlorine, liquid.....	lb.	.15	—	.18
Cobalt oxide.....	lb.	1.55	—	1.60
Copper.....	100 lb.	1.05	—	1.10
Copper carbonate.....	lb.	.33	—	.35
Copper cyanide.....	lb.	.72	—	.74
Copper sulphate, 99 per cent, large crystals.....	lb.	.00½	—	.10
Cream of tartar, crystals.....	lb.	.48	—	.49
Epsom salt, bags.....	100 lb.	3.50	—	4.00
Formaldehyde, 40 per cent.....	lb.	.17	—	.18
Glauber's salt.....	100 lb.	.62	—	.64
Glycerine, bulk, C. P.....	lb.	.58½	—	.59
Iodine, resublimed.....	lb.	3.50	—	—
Iron oxide.....	lb.	.02	—	.08
Lead, acetate, white crystals.....	lb.	.14	—	.14½
Lead arsenate.....	lb.	.10½	—	.11½
Lead nitrate.....	lb.	.16½	—	.17
Litharge, American.....	lb.	.08	—	.19
Lithium carbonate.....	lb.	1.02	—	1.05
Manganese dioxide.....	lb.	.65	—	.66
Magnesium carbonate, tech.....	lb.	.11	—	.11½
Nickel salt, single.....	lb.	.14	—	.14½
Nickel salt, double.....	lb.	.11	—	.12
Phosphorus, red.....	lb.	1.15	—	1.25
Phosphorus, yellow.....	lb.	1.20	—	1.25
Potassium bichromate.....	lb.	.34½	—	.35
Potassium bromide granular.....	lb.	1.00	—	1.05
Potassium carbonate calcined, 80-85 per cent.....	lb.	.55	—	.65
Potassium chlorate, crystals.....	lb.	.58	—	.60
Potassium cyanide, 98-99 per cent.....	lb.	2.10	—	2.20
Potassium iodide.....	lb.	2.90	—	2.92
Potassium muriate 80-85 p. c. basis of 80 p. c.....	ton	375.00	—	400.00
Potassium nitrate.....	lb.	.30	—	.34
Potassium permanganate.....	lb.	3.90	—	4.00
Potassium prussiate, red.....	lb.	2.60	—	2.70
Potassium prussiate, yellow.....	lb.	.95	—	1.00
Potassium sulphate, 90-95 p. c. basis 90 p. c.....	ton	350.00	—	375.00
Rochelle salts.....	lb.	.37½	—	.38½
Sal ammoniac, gray gran.....	lb.	.11	—	.12
Sal ammoniac, white gran.....	lb.	.17	—	.18
Sal soda.....	100 lb.	1.10	—	1.20
Salt cake.....	100 lb.	.90	—	1.00
Silver cyanide.....	oz.	.70	—	—
Silver nitrate.....	oz.	.46½	—	—
Soda ash, 58 per cent, light, flat.....	100 lb.	2.80	—	2.90
Soda ash, 58 per cent, dense, flat.....	100 lb.	3.55	—	3.65
Sodium acetate.....	lb.	.08½	—	.09
Sodium benzoate.....	lb.	6.00	—	6.50
Sodium bicarbonate, domestic.....	100 lb.	2.10	—	2.20
Sodium bicarbonate, English.....	lb.	—	—	.15
Sodium bichromate.....	lb.	.14½	—	.15
Sodium bisulphite, powd.....	lb.	.03½	—	.04
Sodium chlorate.....	lb.	.23½	—	.25
Sodium cyanide.....	lb.	.80	—	.90
Sodium fluoride, commercial.....	lb.	.12	—	.12½
Sodium hypsulphite.....	lb.	.01½	—	.02
Sodium nitrate, refined.....	lb.	.05½	—	.05½
Sodium nitrite.....	lb.	.28	—	.30
Sodium peroxide.....	lb.	.90	—	.95
Sodium phosphate (tri.).....	lb.	.04½	—	.04½
Sodium prussiate, yellow.....	lb.	.30	—	.31
Sodium silicate, liquid—40 deg. Baumé.....	100 lb.	1.50	—	1.60
Sodium sulphide, 30 per cent crystals.....	lb.	.02½	—	.03
Sodium sulphide, 60 per cent, fused.....	lb.	—	—	.03½
Sodium sulphite.....	lb.	.03½	—	.03½
Strontium nitrate.....	lb.	.28	—	.30
Sulphur chloride, drums.....	lb.	.11	—	.12
Sulphur dioxide, liquid, in cylinders.....	lb.	.12	—	.14
Sulphur, flowers, sublimed.....	100 lb.	3.20	—	3.30
Sulphur, roll.....	100 lb.	2.55	—	2.60
Sulphur, crude.....	ton	45.00	—	46.00
Tin bichloride, 50 deg.....	lb.	.19½	—	.20
Tin oxide.....	lb.	.66	—	.67
Tungstic acid, basis 100 per cent.....	lb.	1.40	—	1.50
Zinc carbonate.....	lb.	.25	—	.27
Zinc chloride.....	lb.	.16	—	.17
Zinc cyanide.....	lb.	.50	—	—
Zinc dust, 350 mesh.....	lb.	.19	—	.20
Zinc oxide, American process XX.....	lb.	.13½	—	.14
Zinc sulphate.....	lb.	.05½	—	.06

Coal Tar Products (Crude)

Benzol, pure, water white.....	gal.	.56	—	.60
Benzol, 90 per cent.....	gal.	.57	—	.59
Toluol, pure, water white.....	gal.	1.85	—	2.00
Xylol, pure, water white.....	gal.	.55	—	.65
Solvent naphtha, water white.....	gal.	.18	—	.20
Solvent naphtha, crude, heavy.....	gal.	.13	—	.16
Cresote oil, 25 per cent.....	gal.	.30	—	.32
Dip oil, 20 per cent.....	gal.	.27	—	.30
Pitch, various grades.....	ton	8.00	—	20.00
Carbolic acid, crude, 95-97 per cent.....	lb.	1.00	—	1.05
Carbolic acid, crude, 50 per cent.....	lb.	.55	—	.60
Carbolic acid, crude, 25 per cent.....	lb.	.30	—	.32
Cresol U. S. P.....	lb.	.20	—	—

Intermediates, Etc.

Alpha naphthylamine.....	lb.	.90	—	1.05
Aniline oil.....	lb.	.29	—	.31
Aniline salts.....	lb.	.34	—	.35
Anthracene, 80 per cent.....	lb.	.10	—	—
Benzaldehyde.....	lb.	4.50	—	5.00

Benzidine, base.....	lb.	1.85	—	1.90
Benzidine, sulphate.....	lb.	1.60	—	1.65
Benzoic acid.....	lb.	6.00	—	6.50
Beta naphthol, sublimed.....	lb.	.80	—	.85
Beta naphthylamine com.....	lb.	2.50	—	—
Dichlor benzol.....	lb.	.23	—	.24
Dinitrochlorbenzol.....	lb.	.46	—	.48
Dimethylaniline.....	lb.	.58	—	.59
Diphenylamine.....	lb.	.95	—	1.00
H-acid.....	lb.	Nominal	—	—
Metaphenylenediamine.....	lb.	1.60	—	1.65
Monochlorbenzol.....	lb.	.30	—	.32
Naphthalene, flake.....	lb.	.09½	—	.10
Naphthionic acid, crude.....	lb.	1.50	—	1.75
Nitro naphthalene.....	lb.	.45	—	.50
Ortho-amidophenol.....	lb.	—	—	—
Ortho-toluidine.....	lb.	1.00	—	1.15
Para-amidophenol, base.....	lb.	5.00	—	5.50
Paranitraniline.....	lb.	1.15	—	1.25
Paraphenylenediamine.....	lb.	3.50	—	3.75
Para toluidine.....	lb.	1.90	—	2.00
Phenol, U. S. P.....	lb.	.42	—	.44
Resorcin, technical.....	lb.	9.00	—	—
Resorcin, pure.....	lb.	16.00	—	17.00
Salicylic acid.....	lb.	1.15	—	1.20
Salol.....	lb.	1.70	—	1.75
Sulphanilic acid.....	lb.	.33	—	.35
Tolidin.....	lb.	3.00	—	—
Toluidine-mixture.....	lb.	.75	—	.80

Petroleum Oils

Crude (at the Wells)

Pennsylvania.....	bbl.	3.10	—	—
Corning, Ohio.....	bbl.	2.40	—	—
Somerset, Ky.....	bbl.	2.20	—	—
Wooner, Ohio.....	bbl.	2.18	—	—
Indiana.....	bbl.	1.78	—	—
Illinois.....	bbl.	1.92	—	—
Oklahoma and Kansas.....	bbl.	1.70	—	—
Caddo, La., light.....	bbl.	1.90	—	—
Corsicana, Tex., light.....	bbl.	1.70	—	—
California.....	bbl.	.78	—	.87
Gulf Coast.....	bbl.	1.00	—	—

Lubricants

Black, reduced, 29 gravity, 25-30 cold test.....	gal.	.13½	—	.14
Cylinder, light.....	gal.	.21	—	.26
Cylinder, dark.....	gal.	.18	—	.19
Paraffine, high viscosity.....	gal.	.29½	—	.30
Paraffine, 503 sp. gr.....	gal.	.21½	—	.22
Paraffine, .865 sp. gr.....	gal.	.18½	—	.19

Flotation Oils

(Prices at New York)

Pine oil, steam distilled, sp. gr. 0.925-0.940.....	gal.	.52	—	—
Pine oil, destructively distilled, sp. gr. 0.920-0.940.....	gal.	.48	—	—
Pine-tar oil, sp. gr. 1.025-1.035.....	gal.	.25½	—	—
Pine-tar oil, double refined, sp. gr. 0.965-0.990.....	gal.	.35	—	—
Pine oil, light, sp. gr. 0.930, tank cars, f.o.b. works.....	gal.	.47	—	—
Pine oil, heavy, sp. gr. 1.025, tank cars, f.o.b. works.....	gal.	.26	—	—
Pine tar, thin, sp. gr. 1.060-1.080.....	gal.	.22	—	—
Turpentine, crude, sp. gr. 0.980-1.000.....	gal.	.40	—	—
Hardwood oil, f.o.b. Michigan, sp. gr. 0.960-0.990.....	gal.	.19	—	—
Hardwood oil, f.o.b. Michigan, sp. gr. 1.06-1.08.....	gal.	.19	—	—

Vegetable and Other Oils

China wood oil.....	lb.	.16	—	.16½
Cottonseed oil, crude.....	gal.	1.11	—	—
Lined oil, raw, cars.....	gal.	1.22	—	—
Peanut oil, crude.....	gal.	1.15	—	—
Rosin oil, first run.....	gal.	.38	—	—
Rosin oil, fourth run.....	gal.	.67	—	—
Soya bean oil, Manchuria.....	lb.	.14½	—	—
Turpentine, spirits.....	gal.	.49	—	—

Miscellaneous Materials

Barytes, floated, white, foreign.....	ton	38.00	—	40.00
Barytes, floated, white, domestic.....	ton	28.00	—	32.00
Beeswax, white, pure.....	lb.	.55	—	.60
Carnauba wax, flor.....	lb.	.51	—	—
Casein.....	lb.	.19	—	.28
Chalk, light, precipitated, English.....	lb.	.03	—	.06
Feldspar.....	ton	8.00	—	12.00
Fuller's earth, powdered.....	100 lb.	.80	—	1.05
Ozokerite, crude, brown.....	lb.	.60	—	.70
Ozokerite, American.....	lb.	.35	—	—
Red lead, dry, carloads.....	lb.	.12	—	—
Rosin, 280 lb.....	bbl.	6.35	—	—
Soapstone.....	ton	10.00	—	12.50
Talc, American, white.....	ton	10.00	—	13.00
White lead, dry.....	lb.	.10½	—	—

Refractories, Etc.

(F.O.B. Works)

Chrome brick.....	net ton	Nominal	—	—
Chrome cement, Grecian.....	net ton	60.00	—	—
Clay brick 1st quality fireclay.....	per 1000	45.00	—	—
Clay brick, second quality.....	per 1000	30.00	—	—
Magnesite, raw.....	ton	30.00	—	35.00
Magnesite, calcined.....	ton	40.00	—	55.00
Magnesite, Grecian, dead burned.....	net ton	90.00	—	—
Magnesia brick, Grecian, 9x4½x2½.....	net ton	140.00	—	—
Silica brick.....	per 1000	45.00	—	—

Ferroalloys

Ferrochromium.....	lb.	Nominal	—	—
Ferromanganese, domestic, delivered.....	ton	400.00	—	425.00
Ferromanganese, English.....	ton	200.00	—	—
Ferromolybdenum, per lb. of Mo.....	lb.	4.25	—	—
Ferrosilicon, 50 per cent, carloads, del., Pittsburgh.....	ton	240.00	—	250.00
Ferrosilicon, 50 per cent, contract.....	ton	100.00	—	—
Ferrotungsten, 75-85 per cent, f.o.b. Pittsburgh.....	lb.	2.00	—	—
Ferrovandium, f.o.b. works.....	lb.	3.25	—	3.50

INDUSTRIAL

Financial, Construction and Manufacturers' News

Financial New Companies

Adirondack Platinum-Gold Corporation, Eddyville, N. Y., has been incorporated with a capital of \$35,000. The incorporators are J. F. Curtin, A. W. Britton, H. B. Davis, 28 Nassau Street, New York City.

American Chemical Products Co., Connelville, Pa., has been incorporated with a capital of \$6,000. The incorporators are N. J. Davidson, Connelville; H. L. Mitchell, W. E. Moore, Pittsburgh.

Anglo-American Development Co., Del., has been incorporated with a capital of \$100,000 to acquire oil and mining lands and develop them. The incorporators are M. E. Smith, A. Smith, M. E. Doto.

The Architectural Steel Products Co., Inc., Albany, N. Y., has been incorporated with a capital of \$15,000. The incorporators are M. Donnelly and Charles Heffernan of Brooklyn and Rudolph Ludwig of New York City.

Atwood Refining Co., Oklahoma City, Okla., has been incorporated with a capital of \$1,000,000. The incorporators are W. Atwood, R. W. Carson, I. S. Mahan, Oklahoma City.

Belding Foundry Company, Belding, Mich., has been incorporated with a capital of \$25,000 to make iron castings of every description. The incorporators are John C. Jenkins, Raymond A. Stoke, A. B. Johnson, W. F. Sandell.

Bretling Iron Company, Delaware, has been incorporated with a capital of \$18,000,000 to do a general mining, milling and refining of ores, metals, etc. The incorporators are Harry McDaniel, Jr., Arthur J. Kingsbury.

B. Brown & Bro., Inc., New York City, has been incorporated with a capital of \$100,000 to manufacture oils, colors, chemicals. The incorporators are J. C. Brown, D. R. Bernstein and L. Skutch.

Caddo Oil Co., New York, has been incorporated with a capital of \$500,000 to dispose of oil and natural gas lands. The incorporators are L. H. Gunther, H. B. Davis.

Central Glass Co., Delaware, has been incorporated with a capital of \$1,000,000 to manufacture glass of all kinds. The incorporators are C. M. Egner, L. Rimlinger.

Columbia Mineral Products Co., Columbia, S. C., has been incorporated with a capital of \$20,000 to manufacture kaolin. The incorporators are F. L. Whittemore, F. W. Attwood, W. J. Keenan, Jr.

Corcoran Chemical Co., Durham, N. C., has been incorporated with a capital of \$125,000 to carry on the business of chemists and druggists.

D'Arbonne Lumber & Oil Co., Wilmington, Del., has been incorporated with a capital of \$1,000,000 to deal in timber and oil lands and market the products of same.

Dixie Graphite Co., Delaware, has been incorporated with a capital of \$150,000 to manufacture graphite, iron and steel. The incorporators are C. E. Brooks, Ashland, Ala.; W. L. Shumate, Jr., F. W. McMiller, J. F. Berry, Birmingham, Ala.

Eastern Aniline and Chemical Co., Inc., has been incorporated in Delaware with a capital of \$2,500,000 to manufacture chemicals, drugs, paints, etc. The incorporators are C. L. Jordan, George F. Barght, G. G. Gates, Yonkers, N. Y.

Electro Metallurgical Sales Corp., Niagara Falls, N. Y., has been incorporated with a capital of \$500,000 to manufacture steel, iron and metallurgical products. E. F. Price, F. E. Lewton, G. C. Furness, 308 West Seventy-ninth Street.

The Empire Gas Co. has been incorporated with a capital of \$500,000. A. J. Duncan, incorporator.

Everett Oil Corp., Delaware, has been incorporated with a capital of \$50,000 to search and drill for oil and its products. The incorporators are S. B. Howard, H. B. Davis.

Far Island Producing & Refining Corp., Delaware, has been incorporated with a capital of \$2,000,000 to carry on business in oil and gas.

The Fostoria Pressed Steel Co., Fostoria, Ohio, has been incorporated with a capital of \$100,000. The incorporators are W. O. Allen, G. D. Pfier, H. Rothrock, E. V. Wolfe and George E. Schroth.

Gas Oil Chemical Co., Chicago, Ill., has

been incorporated with a capital of \$50,000 to manufacture and deal in drip oil, holder oil and other products.

Gloekler Foundry Company, Pittsburgh, Pa., has been incorporated with a capital of \$10,000. J. Edward Gloekler, incorporator.

The Gold Leaf Natural Dye Co., Inc., New York, has been incorporated with a capital of \$500,000 to deal in dyes, chemicals, colors and drugs. The incorporators are R. L. Warner, H. Campbell, 150 Nassau Street.

Good Chemical Co., Inc., Roanoke, Va., has been incorporated with a capital of \$50,000 to conduct an oil business. The incorporators are L. M. Good, C. W. Robinson.

Grass-Fiber Pulp & Paper Corporation, Dover, Del., has been incorporated with a capital of \$150,000 to manufacture paper and paper products.

Hoosier Rolling Mill Co., Inc., Terre Haute, has been incorporated with a capital of \$100,000 to deal in lumber and other material. The incorporators are W. M. Lewis, S. T. Greenberg, J. R. Finkelstein.

Imperial Chemical Works, Warren, Pa., has been incorporated with a capital of \$15,000 to manufacture acids. Clarence J. Hesen, incorporator.

Interstate Oil and Refining Co., Delaware, has been incorporated with a capital of \$3,000,000 to bore for petroleum and natural gas. The incorporators are H. F. Gaviland, J. A. Reynolds, F. R. Hansell, J. Vernon Pinn, S. C. Seymour, Camden, N. J. Isle of Pines Turpentine Co., Moultrie, Ga., has been incorporated with a capital of \$50,000. The incorporators are A. W. Chase, E. B. Malone.

Jaffrey Manufacturing Co., Trenton, N. J., has been incorporated with a capital of \$50,000 to manufacture chemicals, dyestuffs, color, etc. The incorporators are B. D. Phillips, New York; H. H. Umberger, L. E. Conover, Trenton.

Lafayette Paper Mills, Inc., New York City, has been incorporated with a capital of \$200,000 to manufacture paper. The incorporators are S. Helfgott, 1241 Forty-first Street, D. Carson, 1205 Forty-third Street, Brooklyn; M. Klein, 553 West 187th Street, New York City.

The Lemaco Chemical Co., Hackensack, N. J., has been incorporated with a capital of \$100,000 to manufacture chemicals, pharmaceutical chemicals and other preparations and articles. The incorporators are B. Barnett, Paterson; James H. McClellan, Boston, Mass.; I. Cohen, Ridgewood.

L. J. Lewery & Co., Inc., New York City has been incorporated with a capital of \$25,000 to manufacture chemicals, etc. The incorporators are L. J. Lewery, W. Sutton, M. A. Kahl.

Little & Elfstrom Mining Co., Seattle, Wash., has been incorporated with a capital of \$1,000,000. The incorporators are J. W. Little, John Willes, Otto Elfstrom, Charles Anderson, Alexander Fodenberg.

Loraline Chemical Works, Inc., Wilmington, Del., has been incorporated with a capital of \$75,000 to deal in drugs, chemicals and toilet goods. The incorporators are W. G. Graistaff, C. E. Tate, R. N. Thomas, C. C. Pitts, E. F. Curtis.

Macon Fisheries Co. of Beaufort, N. C., has been incorporated with a capital of \$49,500 to manufacture fertilizer and other materials. The incorporators are L. J. Up-ton, L. M. Russells.

Max Marx Color and Chemical Co., 192 Colt Street, Irvington, N. J., has been incorporated with a capital of \$100,000 to manufacture chemicals, colors, etc.

Massillon Smelter Co., Cleveland, Ohio, has been incorporated with a capital of \$10,000 to smelt metallic ores, such as copper, manganese, bauxite, etc.

Milton Fibre Board Company, Haverhill, Mass., has been incorporated with a capital of \$100,000. The incorporators are George R. Burns, Haverhill; George W. Tucker, Lawrence; George D. Knightly, Lawrence.

Mullen Leather Co., Boston, Mass., has been incorporated with a capital of \$20,000. The incorporators are S. J. Mullen, S. Star-sier, Charles H. Poor.

National Gelatine & Glue Works, Inc., New York City, has been incorporated with a capital of \$5,000 to manufacture glue, gelatine and mica. The incorporators are A. J. and W. Alexander, 229 West Ninety-seventh Street.

North American Oil Corporation, Wil-

mington, Del., has been incorporated with a capital of \$12,500,000.

Northern Wyoming Oil Co., Spokane, Wash., has been incorporated with a capital of \$100,000. The incorporators are H. L. McWilliams, E. D. Weller, Ben Collins, H. S. Knudson and J. E. Burbank.

Olive Hill Oil & Gas Co., Dover, has been incorporated with a capital of \$500,000 to produce, refine and market crude oil and its products and natural gas.

The Portola Oil Co., Wilmington, Del., has been incorporated with a capital of \$150,000 to manufacture all kinds of oils, fats, greases, etc.

Ramapo Finishing Corp., Sloatsburg, N. Y., has been incorporated with a capital of \$250,000. Bleaching and dyeing textiles. The incorporators are T. I. Whalen, C. Rush.

Rome Iron Mills, Inc., Rome, N. Y., has been incorporated with a capital of \$2,000,000 to manufacture iron, steel, manganese, etc. The incorporators are E. R. Series, East Orange, N. J.; A. R. Palmer, Madison, N. J.; H. G. Wenzel, Jr., 2 Ferry Street, Woodhaven.

Royal Harsco, Inc., Union, N. J., has been incorporated with a capital of \$1,000,000 to treat, dye and print silk, cotton and wool textiles. The incorporators are F. H. McCauley, F. Klumpp, W. L. Wirebeiauer, A. I. Snider.

Rucker Oil Products Co., Delaware, has been incorporated with a capital of \$4,000,000 to maintain oil companies, acquire oil lands, and develop the same. The incorporators are Herbert E. Latter, C. L. Rimlinger, Clement M. Egner.

The Scranton Foundry and Engine Works, New York City, has been incorporated with a capital of \$100,000 to deal in iron, steel, copper, wood and their products. The incorporators are W. H. Hayes, D. C. Jacobus, J. J. Fitzgerald, 110 West 106th Street. Shortsville Paper Co., Inc., Shortsville, N. Y., has been incorporated with a capital of \$100,000 to manufacture paper. The incorporators are E. M. and B. F. Hall, Shortsville.

Sinclair Panama Oil Co., Delaware, has been incorporated with a capital of \$5,000,000 to prospect for oil, natural gas, petroleum and to develop them. The incorporators are Herbert E. Latter, C. L. Rimlinger, C. M. Egner.

Star Iron Works Co., Gonawanda, N. Y., has been incorporated with a capital of \$75,000. The incorporators are William W. Watson, C. E. Eschwind, D. H. Foster.

State Line Zinc & Lead Co., Boston, Mass., has been incorporated with a capital of \$500,000. The incorporators are A. W. Pope, Malcolm Green, A. L. King.

Steel Products Co., Hartford, Conn., has been incorporated with a capital of \$700,000. The incorporators are C. S. Robbins, New Haven; Edward D. Robbins, New Haven; B. E. Case, Hartford.

Syracuse Alloy Steel Co., Syracuse, N. Y., has been incorporated with a capital of \$25,000. The incorporators are C. A. Lawton, M. C. Warwick, F. C. Rabb, J. B. Lynch and Frederick Bertrich.

Tennessee Products Company, Nashville, Tenn., has been incorporated with a capital of \$25,000 to manufacture potash, nicotine, fertilizer, etc. The incorporators are J. W. Rudolph, C. H. Smith, John T. Cunningham, T. D. Thompson and Wisdom Rudolph.

Construction and Operation

Arkansas

LITTLE ROCK.—The Arkansas Fertilizer Company will rebuild its plant, which was destroyed by fire some time ago. The repairs and new machinery to be installed will cost about \$25,000.

California

LONG BEACH.—The National Kelp Potash Company will rebuild its plant which was destroyed by fire. The company has a large contract for potash with an eastern company.

LOS ANGELES.—Development work in the California oil fields for the first three months of 1917 amounts to twice the results achieved a year ago for the same period. During this period this year 287 new wells were started.

SAN FRANCISCO.—The Jewell Malleable Steel Company will erect a plant here. Excepting a small foundry in the southern part of California, this is said to be the only industry of its kind on the coast.

Colorado

DENVER.—The Linde Air Products Co. will build a \$100,000 factory to manufacture oxygen. Denver is considered a splendid distributing point.

Delaware

WILMINGTON.—The Wilmington Steel Company, a subsidiary of the Midvale Steel Company, is opening a new rolling mill with five open-hearth furnaces of 50 tons capacity. It is said that the Midvale interests are preparing to develop Cuban ore properties which will be brought to the Wilmington plant. The Wilmington company is operating the plant which once belonged to the Diamond State Steel Company and which had lain idle for fourteen years.

Georgia

SAVANNAH.—The Savannah Sugar Refining Corporation will build a large barrel factory at its plant at Fort Wentworth. The factory will turn out about 2700 barrels a day. The large refining buildings are practically complete, but there is considerable work to be done before the filters and other apparatus are in perfect order. The company will manufacture white sugar.

Idaho

KAMIAH.—Kamiah Asbestos Manufacturing Company, here, has a tentative order from Japanese interests to purchase 1800 tons of asbestos fiber at a price of \$45,000. The Japan merchants first wish a sample shipment of 10 tons. The company owns huge deposits of asbestos near Kamiah, where it has a small plant. Plant is manufacturing calcimine from asbestos and other ingredients.

KELLOGG.—The Washington Water Power Company has completed erection of its new substation in this city, from which it will supply current to operate the smelter of the Bunker Hill & Sullivan Mining and Concentrating Company, now nearing completion. About 4000 hp. will be required for the operation of the smelter and 3000 hp. for the mill.

LEADORE.—The Sunset Mining Company, here, plans installation of a mill, which will have capacity of 200 tons daily. Company owns large silver and lead properties near this city.

LEONIA.—Directors of the Idaho Copper Mining Company recently voted to increase the capital stock of the company from \$1,000,000 to \$2,000,000, to finance further developments, and name of company changed to Idaho Lead & Copper Company. E. J. Merrin, president.

STILES.—More than \$150,000 will be spent in the vicinity of Stiles by C. E. Sample of Golden, and associates, by installation of stamp mills at the properties of the Golden Mining & Milling Company and at the New York mine.

Illinois

MOLINE.—The Republic Iron & Steel mills is erecting a large addition, costing \$28,000. A two-story office will also be erected.

ROCK ISLAND.—The new paint factory of the Illinois Oil Company will be enlarged at a cost of \$35,000.

Indiana

HUNTINGTON.—The Huntington Steel Foundry Company will build a two-story addition to its plant, 40 by 80 ft.

RICHMOND.—The Swayne Robinson Company is building a large addition to its factory. The building will be 180 ft. long by 60 ft. wide and one story, and will be used as a foundry. It will be finished by July 1.

Kansas

WICHITA.—The Augusta Petroleum & Refining Company has purchased a ten-acre tract of land on which it will build a 3000 barrel oil refinery. The company is capitalized at \$250,000 and owns leases in the Butler County oil fields.

Maine

ORONO.—The Orono Pulp & Paper Company is making extensive improvements at its plant.

Maryland

BALTIMORE.—The Baltimore Tube Company is reported to be planning for the enlargement of its plant on Bayard Street for the rolling of sheet copper tubing.

Massachusetts

NEW BEDFORD.—The Taunton-New Bedford Copper Company is building an addition to its plant which will cost about \$400,000. The addition will include a rolling mill and a machine shop. They will be equipped with the most modern machinery.

Mexico

MEXICO CITY.—Metal foundries, smelters and metallurgical plants have been instructed by the department of fomento to resume operations before May 28, as conditions, it is asserted, are now such that the raw materials from the mines are available.

Michigan

PETOSKY.—The paper mill here will construct an addition to its bleach manufacturing plant. When it is completed the plant will be able to manufacture all the bleach necessary to take care of the increase in pulp production and make the entire output of the mill bleached pulp.

New Jersey

ATLANTIC CITY.—The old paper mill at Pleasant Mills will shortly be put into operation in charge of Alexander McKeone. Paper will be made from salted hay.

CHROME.—E. C. Klipstein & Company has awarded a contract to the William L. Crow Construction Company, 103 Park Avenue, New York, for the erection of five buildings at South Charleston, W. Va., for its proposed new chemical plant. Other contracts have been awarded to Almirall & Company, 1 Dominick Street, New York, for three other structures.

ELIZABETH.—The Bayway Chemical Company will erect a subsidiary building at its Bayway plant.

IRVINGTON (Newark).—The Jackson Chemical Works, recently incorporated, has filed plans for the erection of a one-story addition to its plant at 487 Chancellor Avenue. Harry DeG. King and John E. Jackson are heads of the company.

JERSEY CITY.—The Seydell Manufacturing Company, 88 Forest Street, manufacturers of chemicals, will build a 3-story addition to its plant to cost about \$34,000.

JERSEY CITY.—Fire recently destroyed a portion of the plant of the Syn Chemical Manufacturing Company, Culver Avenue, with loss estimated at about \$10,000.

JERSEY CITY.—The Interstate Chemical Company, 673 Garfield Avenue, has filed plans for the erection of a 1-story addition.

NEWARK.—The American Oil Export Company is planning for extensions to its oil refining plant at Port Newark Terminal. The company has recently acquired about 6 acres of property for this purpose.

NEWARK.—George H. Segal Company, 95 William Street, New York City, has leased property on Meadow Street, Kearny meadow section, consisting of a 2-story factory building, and will establish new chemical manufacturing plant.

NEWARK.—O. W. Young's Oils, Inc., has acquired property at 33 Ross Street, and will establish an oil refining plant to specialize in the production of greases, lubricants, etc.

NEWARK.—The Elizabethtown Smelting Company has filed plans for the erection of a 1-story addition to its plant at 511 Mulberry Street.

PAULSBORO.—The Mantua Chemical Company will soon commence the erection of a 1-story crusher plant, about 10 x 40 ft. and 10 x 65 ft. Harrison Brothers & Company, Inc., Thirty-fifth Street, Philadelphia, Pa., operate this company.

SALEM.—The Salem Brass & Iron Foundry Manufacturing Company is planning for the early operation of the former plant of the Hess Steel Company as an addition to its works. The plant has been reconstructed and machinery and equipment are now being installed.

New York

BUFFALO.—The Schoellkopf Aniline & Chemical Co. is planning to build an extension which will cost \$135,000. The concern intends to put up an ice plant which will cost \$65,000, a factory and machine shop will cost \$70,000. This company has spent millions of dollars during the last two years in building.

FAYETTEVILLE.—McIntyre Brothers & Rondebush, Inc., manufacturers of paper, are taking bids for the erection of an addition to their plant, about 60 x 185 ft. The company will also build a new reinforced concrete spillway for water power for plant operation.

NEW YORK CITY.—The Sinclair Gulf Corporation has obtained a concession from the Republic of Panama to explore about ten million acres for petroleum. The property involved is on both coasts. The work will be under the direction of Mr. D. T. MacDonald.

SYRACUSE.—The McIntyre Brothers & Rondebush, Inc., are planning to build a large mill at Fayetteville. The new buildings and equipment will more than triple the output of the plant.

Ohio

COLUMBUS.—The Carbo-Hydrogen Company of America with head office at Pittsburgh has purchased an acre and a half of ground from the Rood Box Company and will erect a factory building.

YOUNGSTOWN.—Extensions costing about \$4,000,000 are being planned by the Brier Hill Steel Co. and the Trumbull Steel Co. Both companies will erect large plants.

Oklahoma

BRISTOW.—The Concord Oil Company, capitalized at \$7,000,000, will erect a refinery here. The plant will manufacture all of the products and by-products of oil.

Oregon

RILEY.—J. H. Morton and L. M. Dunn, here, will organize a company to exploit 3800 acres of rich nitrate rock on the border between Lake and Harney counties, near Bend, Ore.

Pennsylvania

ALLENTOWN.—The National Slag Company is planning for the installation of a new 600-ton crusher plant with necessary operating equipment. The production of this plant is being used by the Bethlehem Steel Company at its Cornwall blast furnaces.

BELLWOOD.—The Bellwood Foundry & Machine Company has filed articles of incorporation with a capital of \$20,000 to operate a local iron and steel casting works. The former plant of the Bellwood Manufacturing Company has been acquired for initial operations. It is reported that extensions are considered. George C. Bland, Tipton, is head of the company.

BRIDGEPORT.—The plant of Joseph H. Roach & Company, manufacturers of all-steel water tube boilers, has been purchased by the Badenhausen Company, Philadelphia. Increased output is contemplated.

HARRISBURG.—The former plant of the Lochiel Steel Company has been acquired by the American Manganese Manufacturing Company (Edward E. Marshall, president), Bullitt Building, Philadelphia. Extensive improvements and extensions are now being made to effect an initial capacity of about 125 tons of pig iron and 15 tons of ferromanganese per day. This plant has recently been in the possession of the Bethlehem Steel Company.

HARRISBURG.—The Harrisburg Welding, Brazing & Machine Works, 947 Cameron Street, has completed the erection of an addition to its plant, to be used for brazing and welding work. A. A. Hayward and J. C. Garverick are heads of the company.

KITTANNING.—The Kittanning Iron & Steel Manufacturing Company is now controlled by Charles McKnight of Pittsburgh, banker and manufacturer. It is said that \$1,000,000 was involved in the transfer.

MARIETTA.—The National Casting Company has acquired the former plant occupied by the Marietta Manufacturing Company, and will use the structure for extensions.

NEWTOWN.—The Newtown Porcelain Works has been organized by officials of the Imperial Porcelain Company, Trenton, N. J., to take over the plant of the Newtown China Company, and operate the works for the manufacture of electric porcelain goods. The plant will be run as a branch of the main plant at Trenton. The Imperial company is also arranging for the erection of a new plant at Neptune City, N. J., with initial operations to employ about 200 people. Frederick A. Duggan and B. B. Dinmore are heads of the company.

PENNSBURG.—Fire, May 13, destroyed the paper mill of the Perkiomen Paper Company, with loss estimated at \$40,000. Charles G. Hillegass is head of the company.

PHILADELPHIA.—The General Manufacturing Company, Swanson Street and Snyder Avenue, has filed plans for the erection of a 1-story addition to its plant.

PHILADELPHIA.—Powers-Weightman-Rosengarten Company, manufacturers of sulphuric, nitric and mixed acids, will build a 1-story addition to its plant at 800 North Hutchinson Street, about 40 x 50 ft., to cost \$14,000.

PITTSBURGH.—The Pennsylvania Railroad Company will build a 1-story addition to its brass working plant on Pennsylvania Avenue to cost about \$10,000.

POTTSTOWN.—The Nagle Steel Company will inaugurate operations at the former plant of the Potts Brothers Iron Company, recently acquired. The plate mill and other departments of the plant have been remodeled and improved and will soon be operated at full capacity. The company is also arranging for improvement work at its Rahway, N. J., plant.

READING.—The Reading Steel Casting Company is having plans prepared for a new 1-story steel frame addition, about 40 x 60 ft. William H. Dechart & Son, Baer Building, are the architects.

SCRANTON.—The Maccar Truck Company is arranging for the immediate erection of a 1-story reinforced-concrete and steel addition about 75 x 300 ft., to cost approximately \$100,000. It is also planned to build a new power house in connection.

WILKES-BARRE.—The Pressed Steel Company, North Pennsylvania Avenue, specializing in the manufacture of steel plates, sheet piling, etc., will build a 1-story addition, about 57 x 80 ft.

Tennessee

LEWISBURG.—The Lewisburg Foundry Company will enlarge its plant, thereby almost doubling its capacity.

NASHVILLE.—The Hart Manufacturing Company of Grand Rapids, Mich., will build a plant in Knoxville, where it will manufacture brass articles. Knoxville was selected owing to its proximity to the copper and zinc fields.

Texas

HOUSTON.—The Texas Chemical Company will build a brick and steel chemical plant, which will cost \$51,000. It will be the first unit of series of plants on the channel. Fertilizer and various by-products, which include ammonia and greases and bone charcoal for sugar refining will form the regular output. The Texas Chemical Company is affiliated with Stauffer interests of California.

Utah

SALT LAKE CITY.—The Lakeview Mining Company has been taken over by a syndicate of New York capitalists. The property consists of lead and zinc deposits carrying considerable silver.

Virginia

NEWPORT NEWS.—In connection with proposed plant extensions at the Newport News Shipbuilding & Dry Dock Company's plant a foundry addition is planned for the production of steel castings. H. L. Ferguson is president.

Washington

SEATTLE.—The Pacific Oil Mills of Seattle will expend \$25,000 in enlarged plant and facilities at Seattle. Arrangements have been completed whereby the company will lease a 7-acre tract on the Dawanish Waterway from King County. The county will also construct a dock in front of the tract which the company will rent.

SEATTLE.—The Superior Steel Corporation, originally organized with \$750,000, is planning to manufacture steel here from ore mined in British Columbia. The incorporators are G. L. Casey, T. H. Pidduck and E. W. Frech of Seattle. Mr. Casey is head of the company, and has been located here for about ten years.

SEATTLE.—The city of Seattle has given permission to the Sound Paper Company to complete the development of the largest paper mill in the United States, which it contemplates building. Mr. H. O. Pond is president of the company. The company was incorporated several months ago with a capital of \$6,000,000 and it is estimated that \$10,000,000 will be required to build the plant and as much more for the full development of the Sultan water power project. The Pacific Power Development Company had plans for the development of this water power for use by the city, but the city decided it was not needed, and the paper company is now free to go ahead and obtain Government permission.

SEATTLE.—The West Coast Chemical Company is now planning to acquire from 25 to 50 acres on which it proposes to erect a plant for the manufacture of coal tar products.

SPOKANE.—The Loon Lake Copper Company, here, plans construction of a mill at its properties, to cost between \$30,000 and \$40,000, and to have capacity of 150 tons daily. Frank G. Crane, secretary-treasurer.

SPOKANE.—R. S. Talbot, here, who is developing several hundred acres of magnesite in the Chewelah district, states a second railroad will be built during the summer. The products are used in steel manufacture.

TACOMA.—It is announced that large supplies of high grade chrome ore will be shipped from a deposit on Cypress Island, near Anacortes, to the Bilrowe Alloys Company's smelter in Tacoma for manufacture into ferrochrome. W. F. Rowe, president of the company, after investigating the deposit, has arranged to take all the ore mined.

West Virginia

WEST CHARLESTON.—The Rollin Chemical Company will double its present factory space and equipment at a cost of about \$6,000,000. Five new buildings will be constructed and equipped and are expected to be finished by January 1 of next year.

WHEELING.—The first unit of the United Zinc Corporation is practically completed. The first unit will employ about 1000 men. The work of building the remainder of the plant will be started and rushed to completion.

Wisconsin

NEENAH.—The John Strange Paper Company is building a new mill adjacent to the present plant. The capital has increased from \$150,000 to \$500,000.

Canada

PRINCETON, B. C.—The British Columbia Copper Company is formulating plans for equipping its mine to produce 2000 tons daily, and installation of a power plant and mill to handle this tonnage.

TRAIL, B. C.—The Consolidated Mining & Smelting Company has announced that settlements on an unusual basis will be made at the Trail smelter during the coke shortage. For silver-lead ore, the company will settle on the average quotations of the second month succeeding the date upon which its coke stock is replenished, and an adequate supply of coke is assured. Advances will be made against shipments if desired as soon as assays are available after arrival, on the usual basis of 90 per cent of an estimated value, calculated upon quotations of the date of arrival. Interest on such advances will be charged at 7 per cent until the date upon the coke is replenished, and regular supplies assured, or the company will make the usual 90 per cent estimated advance upon that date.

GREENWOOD, B. C.—Coke shortage is closing down the Greenwood and Grand Forks smelters and throwing hundreds of men out of employment. Northport is also affected. The present is the first time since the Consolidated Company owned and operated the Trail smelter that the copper furnaces have all been cold at one time. Lack of coke is also said to be playing havoc with the interior smelters.

Manufacturers' Notes

W. A. BUTCHART of Denver, Col., has recently started a new plant of enlarged capacity for the manufacture of concentrating tables and other apparatus at 1320 Eleventh Street, Denver.

THE DRAEGER OXYGEN APPARATUS COMPANY has moved its plant from 413 First Ave., Pittsburgh, Pa., to 807 Hay Street, Wilkinsburgh Station, Pittsburgh, Pa.

THE SMITH GAS ENGINEERING COMPANY of Lexington, Ohio, has furnished the Ball Brothers Manufacturing Company of Muncie, Ind., two four-section units of gas producers for their glass pots; the Standard Aniline Products, Inc., Wappingers Falls, New York, a second gas producer unit, which will be used in heating in the chemical apparatus used by this company; Charles Boldt Company, Cincinnati, Ohio, two three-section gas producer units for use in glass manufacture; and the Dayton Engineering Laboratories Company of Dayton, Ohio, two gas producers for use in its heat treating department.

THE SHARPLES SPECIALTY COMPANY, centrifugal engineers of West Chester, Pa., has opened a New York office at 1410 Astor Trust Building, Forty-second Street and Fifth Avenue, in charge of Max B. Miller. Mr. Miller will look after New York and New England territory.

ARTIFICIAL ABRASIVES.—In our issue of May 1 it was stated that the National Abrasive Company of Boston, Mass., were manufacturers of carbolon. This is a mistake, as carbolon is made by the Exolon Company of Cambridge, Mass. The National Abrasive Company will make its artificial corundum under the name of "Natite."

UNITED FILTERS, INC.—The Kelly Filter Press Company, the Sweetland Filter Press Company, and the American Filter Company have consolidated into a company to be known as the United Filters, Inc. The company is sole owner of all patents covering the Kelly filters, the Sweetland filters, and the American continuous suction filters. The home office will be at 321 Felt Building, Salt Lake City, and the eastern office at 36 Flatbush Avenue Extension, Brooklyn, N. Y.

TUBE MILL LINING.—The Jasper Quarry Company of Sioux City, Iowa, has placed on the market an adamant silica tube mill lining. It has been used successfully in cyanide plants and cement mills and also in a silica plant in Oregon, Ill. The analysis of the material is as follows: silica, 94.0 per cent; silicate of alumina and potash (orthoclase), 2.4 per cent; hydrous silicate of lime, iron and alumina (epidote), 2.0 per cent; oxide of iron (hematite), 1.6 per cent.

MARDEN, ORTH & HASTINGS COMPANY OPENS NEW BRANCH.—For the better service of its customers in the Far West, Marden, Orth & Hastings Company has just opened a new branch office in the Hoge Building, Seattle. Its Seattle office is the fifth American branch of this firm, which has its main office at 61 Broadway, New York. Besides New York and Seattle, it has branches at 225 Purchase Street, Boston; 130 North Fifth Avenue, Chicago; 316 Clay Street, San Francisco; and Rockefeller Building, Cleveland. The company handles heavy chemicals, coal-tar intermediates, aniline dyes, dyewood extracts, tanning extracts, oils and greases. It has six factories in America, special agents and representatives in all the leading countries of the world, and long-established direct connections with foreign firms for the import of goods not producible in the United States.

HERMAN A. HOLZ, dealer in precision and testing instruments and pyrometers, has moved from 50 Church Street, New York, to larger quarters in the Metropolitan Tower at 1 Madison Avenue.

THE INDUSTRIAL SERVICE & EQUIPMENT COMPANY announces that after May 7, 1917, its offices will be located at 226 Devonshire Street, Boston, Mass.

THE LINK-BELT COMPANY announces that it has printed in colors a portion of President Wilson's proclamation, which is of particular interest to manufacturers at the present time. The company will be glad to send a copy to anyone writing to the Chicago plant.

TRINITROTOLUOL TAX.—The Board of United States General Appraisers recently rendered a decision sustaining the contention of the Giant Powder Company that T. N. T. should come in duty free. In a previous decision it was classified as a coal tar preparation and therefore dutiable.

MARCY MILL HAS NEW HEADQUARTERS.—The Marcy mill department of the Mine & Smelter Supply Company has been moved from Salt Lake City to the Denver office. O. H. Johnson remains in charge of the department.

MEETING OF FERTILIZER COMMITTEES.—A subcommittee of the National Fertilizer Association recently met in New York with several fertilizer and chemical manufacturers, following conferences in Washington, and discussed plans for the supply and distribution of fertilizers. Horace Bowker, chairman of the subcommittee, presided at the meeting. All of the producers present were ready to place their plants at the service of the Government. One question of importance which came up was concerned with the supply of pyrites, of which 1,250,000 tons comes normally from Spain. Submarines and the scarcity of shipping have cut down the imports. The manufacturers were told that steps were being taken to get domestic supplies. It was added that the shortage of sulphur, formerly obtained from abroad, was being remedied by increased American production.

GOLDSCHMIDT THERMIT OPENS PITTSBURGH BRANCH.—The Goldschmidt Thermit Company, 120 Broadway, New York, announced in the last issue of *Reactions* that a Pittsburgh branch office and shop would be opened in the near future in charge of H. D. Kelley, who has represented the company in that district since 1910. Edwin B. Bloom will also be attached to this office. The shop will carry a large stock of Thermit, crucibles, preheaters, wax, molding material, and in fact everything required for Thermit welding operations, and in the case of emergencies customers can obtain their supplies from this store room and avoid the delay incident to obtaining shipments from Jersey City.

DYESTUFF PRODUCTION IN THE UNITED STATES.—The Bureau of Foreign and Domestic Commerce, with the co-operation of its district offices, has prepared a revised list of manufacturers in the United States producing coal-tar crudes, intermediates, artificial colors, and vegetable dyestuffs and extracts, copies of which may be obtained from the Bureau and its district and co-operative offices. Forms were prepared and sent to all manufacturers known to be interested in the industry, and to many new companies, notices of whose incorporation have appeared in recent issues of the chemical trade journals. As the primary object was to secure an up-to-date commercial list of domestic manufacturers, there was no attempt to make a complete census or officially verify the data on production. The list furnishes the names, addresses, branch offices, factory locations, principal products, specialties, and future lines of development contemplated, when given, of 158 manufacturers, classified by production under the following headings: Crudes, 23; intermediates, 70; artificial dyestuffs, 99; vegetable dyestuffs and extracts, 18. Of the 50 forms returned, 26 omit the amount of capital stock; the remaining 53 show an aggregate investment of \$100,878,500. Of the 26 firms that did not furnish this item, at least 8 are large concerns representing an additional capitalization of probably \$30,000,000. Of the 78 firms included in the revised list from which forms have not been received, data from trade journals and other sources indicate that 18 of them have a total capitalization of about \$4,000,000.

Of the 80 forms received 30 contain actual or closely estimated figures on output, although only partial returns are furnished in some instances. From data given on these 30 forms, the following totals of current monthly production have been compiled:

No. of firms making returns	Products	Pounds.
16 Crudes:		
	Benzol, toluol and some xylol and phenol.....	*841,200
	Naphthalene, carbolic acid, etc.	6,186,000
20 Intermediates		5,821,650
17 Artificial colors		1,138,100
11 Vegetable dyestuffs and extracts (including some tanning extracts which were not stated separately. Some plants not running to full capacity at present)		6,678,500

*Gallons.

These totals do not include returns from one of the largest manufacturers of crudes, two of the largest producers of aniline dyes representing over \$30,000,000 capital, and two of the most extensive plants making vegetable colors. The showing is gratifying when compared with the census returns of the domestic dyestuff industry for the calendar year 1914, when there were only seven establishments with a total output of 6,619,729 lb.

LEEDS CHEMICAL FIRM BUYS COAL-TAR PLANT. Brotherton & Co. (Ltd.), of Leeds, a firm which manufactures ammonia and coal-tar products, has announced the purchase of the Mersey Chemical Works, built by the Badische Aniline & Soda Fabrick at Bromborough Port, Dirkenhead, near Liverpool, for the manufacture of aniline dyes, according to Commerce Reports. These works were sold at auction in the winding up of alien enemy concerns in this country, and the price paid is given as £135,000 (\$656,977). The head of the firm is quoted by the Yorkshire Evening Post, of Leeds, as stating that when the present extraordinary demand for high explosives has ceased, plant and material will go to a considerable extent to the manufacture of coal-tar intermediate products and dyes.

Brotherton & Co. (Ltd.) controls works established in chronological order as follows: Leeds, 1882; Stourton, 1888; Birmingham, 1893; Liverpool, 1904; Glasgow, 1904; Sunderland, 1905; Workington, 1913; and Middlesbrough, 1913.

THE RUTH-LUND ASSAYING & METALLURGICAL COMPANY announces the opening of offices at 1727 Champa Street, Denver, Col. Mr. A. E. Lund was formerly with the United States Smelting and Refining Co., and for nine years previous to that he was with the A. S. & R. Co. Mr. J. P. Ruth is engaged in mining at Idaho Springs, Col. The office is being equipped for metallurgical testing in addition to the chemical and assaying laboratories.

THE KALBFLEISCH CORPORATION, 31 Union Square West, New York City, announces that all the assets and business of each the Franklin H. Kalbfleisch Company, Erie Chemical Works, Kaloid Com-

pany and Kalbfleisch Corporation have been transferred to and taken over by the Kalbfleisch Corporation, recently organized. In the future conduct of the consolidated businesses, there will be no change of policy or management.

FERROSILICON.—The Keokuk Electro Metals Company of Keokuk, Iowa, for which the Goldschmidt Thermit Company is exclusive representative and sales agent, has been very successful in its production of 50 per cent ferrosilicon, according to *Reactions*, the Goldschmidt house organ. The plant at Keokuk has been in full operation for about six months and the material turned out is of exceptionally high quality. The Goldschmidt Thermit Company is now quoting on a limited quantity of this alloy for shipment during the first quarter of 1918.

RESPIRATORS.—The American La France Fire Engine Company, New York City, manufactures a respirator, known as the Hayward respirator, which is claimed to give adequate protection under gas fume and dust conditions. Comfort to the wearer is obtained from the general design of the device and also from the pneumatic face cushion. The protection to the wearer is obtained by the double filtering device through which all air breathed by the operator is strained.

RESPIRATOR.—The Life Saving Devices Company, Chicago, Ill., has introduced a breathing device for use in poisonous gases. The device supplies fresh air to the wearer. It consists of six principal parts: 1, mouth-piece; 2, air chamber; 3, tube; 4, goggles; 5, nose clip; 6, belt. The apparatus is furnished in a box, with reel for "paying out" the proper amount of hose.

BY-PRODUCTS FROM EXPLOSIVE MANUFACTURE.—Ernest Scott & Company, Fall River, Mass., are introducing equipment to be used in recovering by-products in explosive manufacture. The equipment is used in connection with benzol, T. N. T. and alcohol recovery, and also pure liquid ammonia direct from the gas works and coke-oven liquor. T. N. T. is washed in alcohol and the equipment is for the purpose of recovering from these washings and obtaining T. N. T. residue free from water in a fused condition. A special drying plant is also furnished for the final drying of the T. N. T., if it is desired to dry instead of fuse it. The plant for the manufacture of pure ammonia direct from the gas works and coke oven liquor is used for working up the crude liquors. It is claimed to produce continually in one straightforward operation a pure ammonia containing 30 per cent NH_3 and 0.2 per cent H_2S .

PLATINUM.—The United States alone annually uses about 165,000 ounces of fine platinum and produces less than 1000 ounces of crude platinum, according to the Geological Survey. Realizing the urgent necessity of increasing the country's production of the metals of the platinum group, the United States Geological Survey, Department of the Interior, has planned an investigation in which L. M. Prindle and J. M. Hill, geologists, will visit places in this country where commercial deposits of these metals may be found. Native platinum, the metal, and sperrylite (platinum arsenide) have been found in basic igneous rocks at several places in the world, but not in commercial quantities. The search for platinum in rocks is therefore not likely to obtain an immediate supply of the metal. Persons searching for platinum ores should remember, however, that the assay for platinum is difficult and apparently cannot be successfully made by all commercial assayers. Samples of supposed platinumiferous ores should therefore be sent only to the most competent assayers. The United States Geological Survey has received several reports of discoveries of rich platinum ore in which, as the reports state, "the platinum could not be detected by the ordinary methods of assay." Such statements should be regarded with great caution, for any platinum ore of commercial grade will doubtless yield traces of platinum if tested by the standard methods employed by competent and reliable assayers. The platinum supplies of the world, except a relatively small quantity, have been obtained from placer deposits, notably from those of Russia, which have produced about 95 per cent of the world's output. The largest part of the crude placer platinum now produced in the United States is won by dredges working in California at the west base of the Sierra Nevada, in gravels derived from worn-down lodes and concentrated by natural streams. The greater production from this region than from northwestern California and southwestern Oregon and other places would appear to be due to larger operations rather than to greater or richer deposits. The adequacy of the future supply of platinum in the United States, as far as it can be

assured, depends on the results of work of three kinds—first, the determination of our present supply, particularly of unmanufactured platinum metals, in order that it may be mobilized; second, systematic search for new deposits; and third, scientific exploitation of the deposits discovered, to assure their maximum yield. Work of the first two kinds is now being done by the Geological Survey, and it is hoped that work of the third kind—the technologic work—may be in part done by means of Federal and private investigations. The above data do not take into account the platinum produced by copper refineries and from platinum scrap, which furnish a considerable amount, but not nearly enough to supply the normal demand.

Manufacturers' Catalogs

ALLIS-CHALMERS MANUFACTURING COMPANY, Milwaukee, Wis., has issued Bulletin No. 1632, which describes their centrifugal pumps of all types and also pumping units.

LINK-BELT COMPANY, Chicago, Ill., has issued a number of new catalogs for 1917. Data Book No. 125 is a very attractive book describing silent chains. Book No. 305, 1917, describes traveling water screens for condenser intakes. Book No. 253, 1917, describes drives for cement mill equipment. Book No. 270 describes wagon and truck loaders for handling coal, coke, stone, sand, fertilizer and similar loose materials from storage. Book No. 260 describes classes of Link-Belt commonly used in saw mills.

PENNSYLVANIA FLEXIBLE METALLIC TUBING COMPANY has issued a catalog which describes Pennsylvania metal hose.

ACIERAL COMPANY OF AMERICA, 26 Cortlandt Street, New York City, has issued a little booklet on "Acieral," a metal described as having the strength of steel, lightness of aluminum and non-corrosive.

LIFE SAVING DEVICES COMPANY, Chicago, Ill., has issued an interesting booklet on "Life for the Men in the Trenches."

AMERICAN PULVERIZER COMPANY, East St. Louis, Ill., has issued Catalog No. 21 describing its pulverizers.

THE B. F. GOODRICH RUBBER COMPANY has issued a catalog describing the many uses of Goodrich hard rubber goods.

WERNER & PLEIDERER COMPANY, Saginaw, Mich., has issued an attractive catalog describing "Universal" kneading and mixing machines.

THE MAGNETIC MANUFACTURING COMPANY, Milwaukee, Wis., has issued Bulletin No. 12 describing its type L Magnetic Separator with dynamo attached. The machine is made in five sizes and is applicable for use in a wide variety of industries.

THE U. S. BLOW PIPE & DUST COLLECTING COMPANY, 216-213 North Washtenaw Avenue, Chicago, has issued its catalog E. S. No. 2, describing its high efficiency, slow speed dust collecting systems for use in collecting dust in chemical, cement, paint, paper, furniture factories, etc.

Other New Publications

THE MINERAL RESOURCES OF OREGON. A monthly publication of the Oregon Bureau of Mines and Geology at Corvallis, Ore. This is a handbook of the mining industry of Oregon, giving an alphabetical list of properties; description of mining districts, by H. M. Parks and A. M. Swartley.

ZINC AND CADMIUM IN 1915. Production and Resources, by C. E. Siebenthal, published April 30, 1917, by the Department of the Interior, Washington, D. C.

TESTS OF CLAY MATERIALS AVAILABLE IN ILLINOIS COAL MINES, by R. T. Stull and R. K. Hursh of the Ceramics Department of the University of Illinois, published by the Illinois State Geological Survey.

SANDSTONE QUARRYING IN THE UNITED STATES. By Oliver Bowles. Bulletin 124, Mineral Technology 17, published by the Department of the Interior at Washington, D. C.

AMERICA'S GIBRALTAR—MUSCLE SHOALS.—A brief for the establishment of our national nitrate plant at Muscle Shoals on the Tennessee River. Prepared by Nashville Section, Engineering Association of the South. Published by Muscle Shoals Association, Nashville, Tenn.